MACHINERY

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CHAIN-MAKING EXTRAORDINARY IN A SCRAPLESS PRESS-ROOM

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TWENTY-FIVE thousand links of steel sprocket chain, automatically punched, formed and assembled complete in one day of 10 hours! This is the remarkable, though everyday performance of each of the many automatic chain presses in the factory of the Locke Steel Belt Co., of Bridgeport, Conn., manufacturers of steel belt or sprocket chain.

This chain is made primarily for two classes of work: agricultural machinery, such as planters, mowing machines, harvesters, etc., and for conveying and elevating machinery in the mining, grain and other similar industries. The chain is made to meet all requirements, being made in varying sizes from ½ to 3 inches in width, and in thicknesses from 0.045 to 0.250 inch. During the making of this chain not an ounce of the stock is wasted in scrap, excepting a small "scallop" at the beginning and another at the end of each coil of steel. The part of the link which is punched to form the opening in the center is curled around and serves to connect the link with the one following. Thus, 100 feet of steel ribbon enters the press from one side and emerges on the other side as 95 feet of completed chain—the slight shrinkage being due to the bending of the steel in forming the link. The steel used is of low carbon, and comes in large coils ready for the press, having been rolled to the right width for the size chain into which it is to be made; therefore all sharp edges that would result from sheared stock are eliminated. The chain is easily parted at any desired point by simply bending a link backwards as far as possible and slipping it out edgewise.

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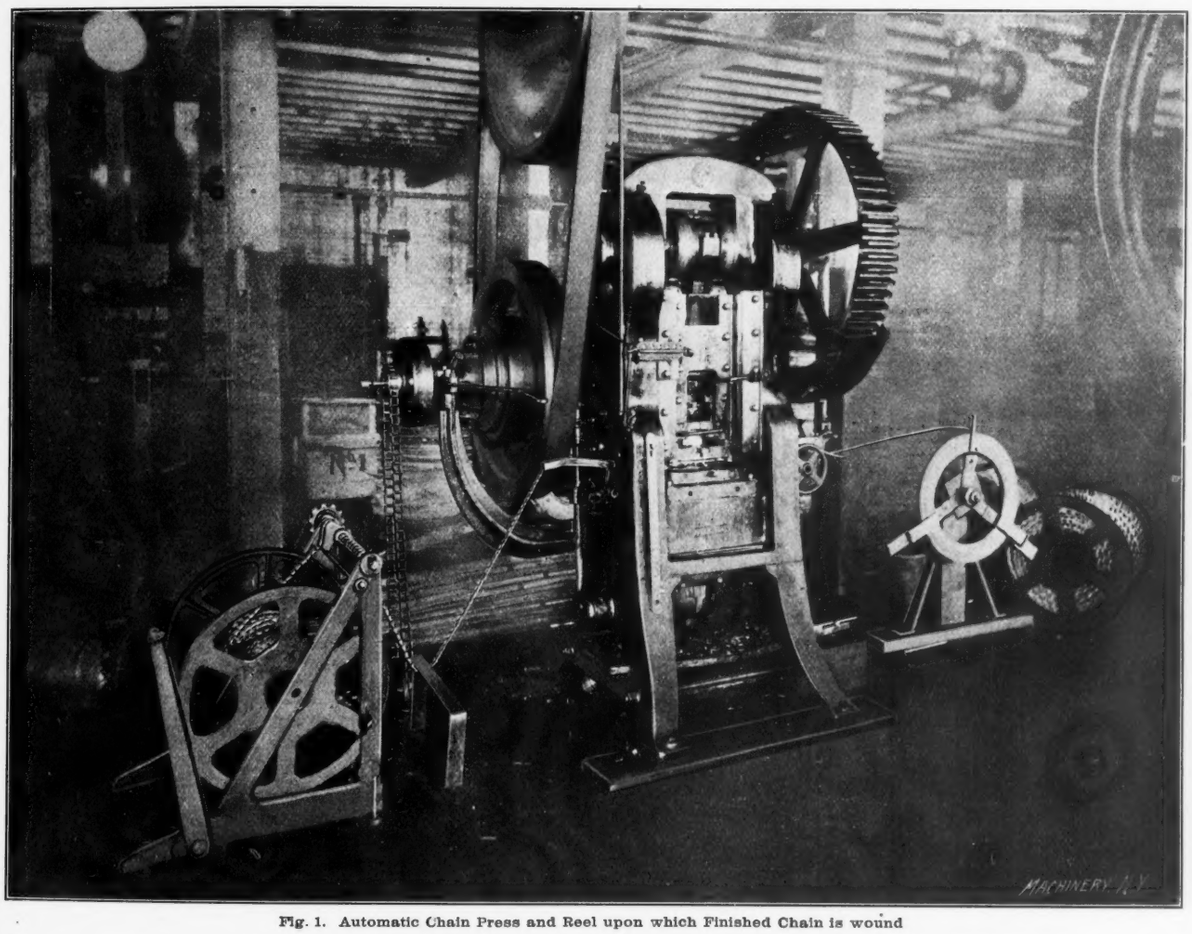

Fig. 1. Automatic Chain Press and Reel upon which Finished Chain is wound

The Automatic Chain Press

The principal feature of the making of this chain is the automatic chain press shown in Fig. 1. This type of machine was specially designed and built for the work, and as the results will testify, it has been highly satisfactory. In general, it resembles and in fact is, a heavy, powerfully-geared, triple-action press. At the right of the illustration may be seen a roll of stock being fed to the press, and just outside of the housings of the press is located the feeding device which is patterned after the familiar grip feed. The main point of this feed is its positive action, which is absolutely necessary on account of the construction of the dies themselves. If, for example, the stock and partly completed links should, through failure of the feed, be advanced but half the required distance, the dies would be badly damaged at the next stroke of the press. Fig. 2 shows the feed in cross section, and its operation is as follows: As the connecting-rod *A* descends (actuated by a crank on the driving wheel) it causes link *B* to recede, carrying with it part *C*, which upon reaching lug *D*, pulls back the feed finger *E* in conjunction with slide *F*, of which it is a part. When the end of the stroke is reached, the forward motion throws the feed finger *E* with its jaw, into the stock, forcing it hard against the corresponding jaw in the slide beneath the stock. Between these two jaws the stock, with the whole slide, is carried forward the distance required to form one link. To prevent the slide *F* from moving forward before finger *E* has gripped the stock, a spring pressure plate *G* is provided which bears against the slide. Before the steel ribbon enters the feed, it

passes between a set of straightening rolls that effectively removes any kinks or dents that would interfere with the action of feed or dies.

The Dies

The dies used in this chain press are very interesting. Although of a modified design, they are after the style of the ordinary follower die; several operations of the chain making being performed upon as many different sections of the stock at each stroke of the press. Another noticeable feature is that all wearing parts, such as punches, scoring chisels, etc., are so arranged in the dies that they may be easily removed without interfering with the rest of the dies, thus facilitating adjustment and renewal. The bodies of the first chain dies were made of tool steel; later machine steel was used, and at the present time machine steel case-hardened to a depth of 1/16 of an inch, is giving better satisfaction than either the unhardened machine steel or the tool steel.

The press tools for the making of the chain are shown in Figs. 3 and 4; these may properly be divided into four parts: the punch *A*, which is held and operated by the main ram of the press; the plate (or stripper) *B*, which is held and operated by the cam-slide; the principal die *C* (also shown in plan view in Fig. 4) fastened to the bed of the press; and the finishing die *D* held and operated by the triple-action mechanism beneath the bed of the press. The function of plate *B* is to hold the body of the chain while punch *A* with its sections *b*, *c*, *e*, *h* and *j* are performing their work on the links and also while finishing die *D* is at work on the under

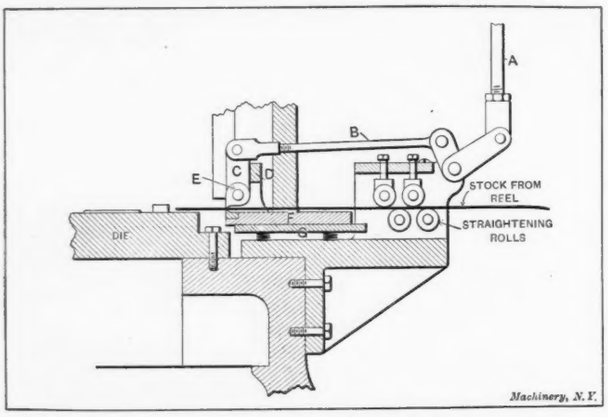

Fig. 2. Positive Feeding Mechanism which advances the Stock the Length of a Link at each Stroke

side of the stock, connecting the links. Just before punch *A* does its work, plate *B* is clamped upon the stock by means of a cam-slide, and held there until the upward stroke releases it.

After leaving the straightening rolls, the stock enters the feeding mechanism already described, and by it is advanced the length of one link under the dies. The first stroke of the press forms the stock over the rounding projection *a* in the die; at the same time, on the under side of the stock, scoring chisels b_1 in the die meet scoring chisels *b* in the punch, on the top side of the stock. While the hump is being formed over *a*, the scoring chisel *c*, located at the top of the hump in the punch, does its work, making a cut clear across and half way through the stock, to facilitate the separation of the links in a succeeding operation. The result of this stroke of the press is indicated by the letters *A* in the illustration, Fig. 5, which shows the appearance of the top and bottom of the stock. While the upward return of the press is under way, the feed is advancing the stock another link's length forward, bringing the hump just formed into position over projection *d* in the die. When the press comes down on the second stroke, scoring chisel e_1 in the die and *e* in the punch make opposite cuts that connect the first two cuts made, near their rear ends, thus outlining three sides of what is to be the open space at the center of the link. With this stroke, figure punch *f*, located in plate *B*, stamps the size of chain into each side of the face of the link. This stroke leaves the stock in the condition shown at *B*, Fig. 5.

The semi-completed links are again forwarded one length, bringing the first hump over shearing knife *g* in the die. On the third down-stroke section *h* in the punch separates the stock on the short scored cross line and pushes it in either direction into the die cavity *i*. This step is plainly shown at *C*. The stock is advanced again for the final operation of completing and connecting the links. As the punch descends, section *j* separates and pushes well down into the die, the center of the link, which operation takes but little pressure, as it has already been deeply scored on both sides. Simultaneously, section *k* of plate *B* severs the link where it has been previously scored. At this point, inverted punch *D*,

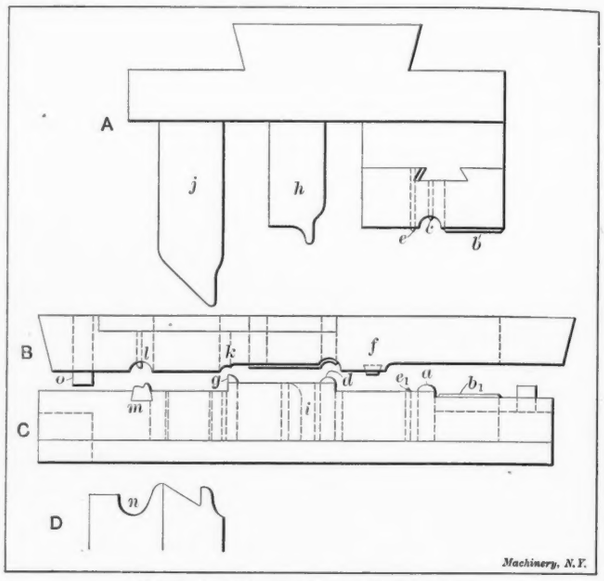

Fig. 3. The Dies used in the Chain Press

operated by the triple-action mechanism beneath the press bed, receives the link tongue in the section *n* and then rises, pushing the link tongue upward and through the center of the link ahead. At the end of its upward journey the tongue strikes the depression in plate *B*, which rounds it nicely into shape, thus connecting it with the forward link and completing the operation of making the chain. A projection *l* is placed in this recess to prevent the link from entirely closing, which would make separation of the completed links

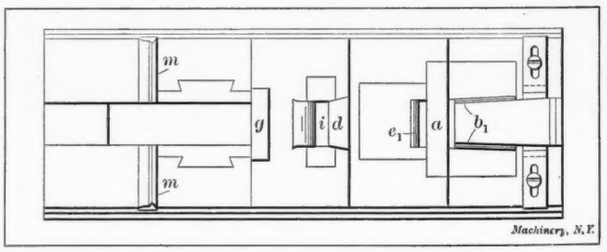

Fig. 4. Plan View of the Die shown in Fig. 3

impossible. During the linking operation, the balance of the stock, outside of the opening, is held by plate *B* against projection *m* and the rest of the die. Stop *o* is added to the dies to insure that the finished chain is pulled from the dies but one link at each stroke of the press. As the link nearest completion is severed from the balance of the stock, it is plain that it would be pulled too far by the winding mechanism if stop *o* did not drop into the opening of the preceding link and hold the link following in position for the linking operation.

While the operations just described have been taking place on the first link other links have of course been started, so that at each stroke of the press four different links are undergoing the various operations and one link is completed and connected with the finished chain that is being wound on the reel at the left of the press.

The Reel

As the completed chain leaves the press it passes under a cam-lever and thence to the reel at the left of the press, as shown in Fig. 1. The solving of the winding problem was not as simple a matter as it would at first appear. To begin

with, the reel weighs over 100 pounds empty and wound with chain, over 500 pounds; therefore the mechanism must be strong and simple, especially as the weight is constantly changing. Secondly, at the starting of the empty reel only about two feet of the chain is wound in one revolution, but when the reel is nearly filled, from eight to ten feet are wound in one revolution, consequently the reel winding must be intermittent. Thirdly, adequate means had to be provided for winding the chain in even layers in order that it might be easily unreeled in subsequent handling.

The reel is about three feet in diameter and made of heavy iron with the sides perforated to reduce the weight as well as to allow the oil better circulation in the tempering bath, which will be described later on. In use, the reel is supported on four small rollers at the base of its support; the rear set acts as driver and transmits the power for turning the reel. When the lever at the side of the reel is thrown down, the rear set of rollers drops back and allows the reel to roll out of the frame. The scheme for obtaining the intermittent motion to the reel-winding is simple. To the driving mechanism (which by the way is operated by power conveyed from the press by a Locke steel chain) is added a friction clutch, controlled by the cam-lever under which the chain passes on its way to the reel. When the chain is being wound too fast, it pulls up against the cam-lever, which by this upward motion disengages the friction clutch and stops the reel. After enough chain accumulates to allow the lever to drop and thus engage the clutch, the reel starts again. The chain is wound in even layers by the screw at the top of the reel which is made with a double (forward and reverse) thread. The carriage over which the chain passes is thus guided slowly backward and forward as the reel is wound, thereby producing a regular and evenly wound reel.

The Hardening Furnace

In many respects the most interesting part of this chain-making plant is the hardening room. To this department the reels of completed chain are brought, and by means of hardening furnaces like those shown in Fig. 6, the soft steel links are automatically hardened. As each link receives the same heat for the same length of time and is quenched in a bath of never-varying temperature, it is obvious that each link of the chain must be thoroughly and evenly hardened.

The illustration Fig. 7 shows a sectional view of the furnace and tank. The incline is lined with firebrick and the heat is supplied through four burners *B* which burn crude petroleum. The chain leaves the reel at the base of the furnace and passing over the sprocket wheel *A* enters the incline, through which it passes at the rate of from 6 to 10 feet a minute, entering the hardening tank shown at the foot of the incline in a bright cherry red heat. After dropping deep into the tank the chain is brought up and over sprocket wheel *C* and thence to the reel where it is wound in the manner already described. By referring to the illustration, it will be noticed that from the time the chain leaves the sprocket wheel *A* at the top of the furnace, until it reaches the sprocket wheel *C* at the end of the hardening tank, it comes in contact with nothing except the red-hot firebrick and water. In this way it is plain that there can be no danger of the hot links being stretched and thereby affecting the pitch of the chain. Provision is made for adjusting the heat in the furnace to suit large or small chain, and the machine is fitted with cone pulleys to regulate the speed at which the chain passes through.

With a line of red hot chain constantly entering the hardening tank, it does not take long to heat the water. To keep the water cool, a large supply pipe is steadily emptying cold water into the tank and at the side is an overflow pipe to carry away the warm water. One little kink on this machine deserves mention, and that is the utilizing of the exhaust heat to dry the chain as it comes out of the tank, dripping wet. As in the other reel drives, the power for this machine and its reel is transmitted by chain similar to that under process of making.

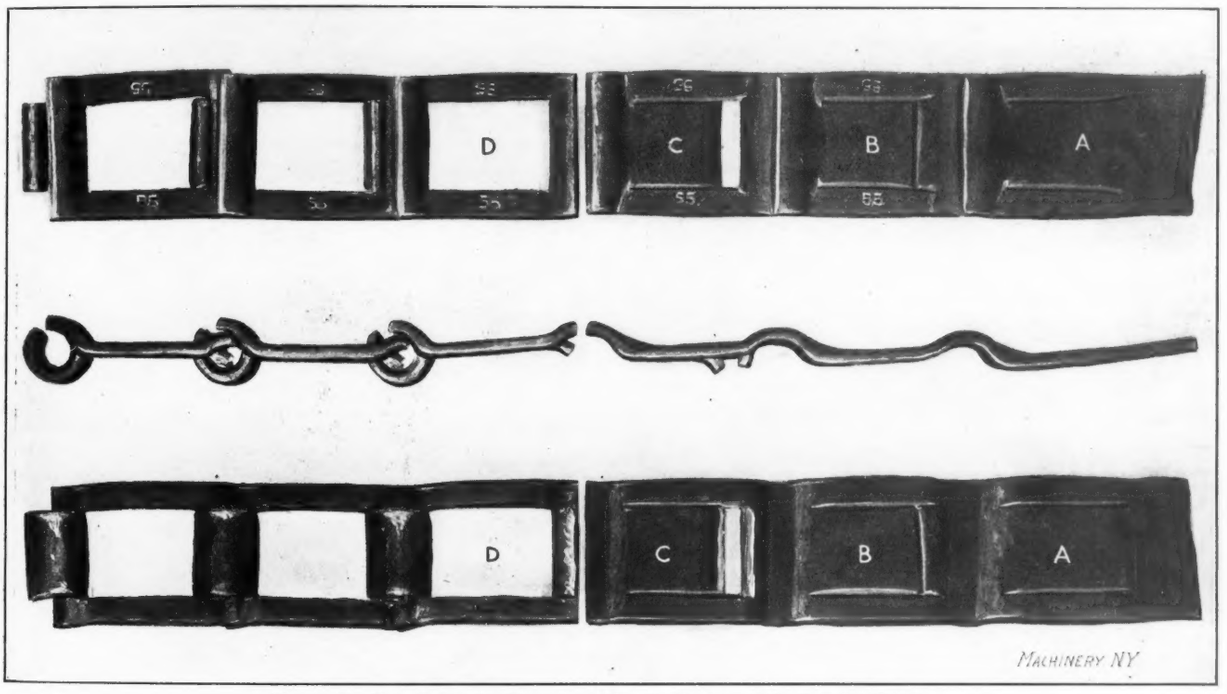

Fig. 5. The Four Successive Steps in making the Chain, and the Completed Links

Tempering

The hardened chain which is of course very brittle in its extreme hardness, now undergoes the tempering process. Great vats of neatsfoot oil are heated to a temperature of 620 degrees F. and into these the full reels of chain are lowered by means of cranes. In this hot oil the reels are left for half an hour, which reduces the temper to a point where the steel has its maximum toughness. Next, the reels of chain are placed on an iron plate which is kept continuously hot, and upon this plate they are left until the adhering oil is baked hard upon the surface of the chain.

Inspection

The tempering operation really completes the chain, yet it is put through a very rigid test which precludes the chance of a single defective link escaping. Fig. 8 shows a view of the testing department and testing apparatus. Here the chain is separated into 10-foot lengths or, if required, into special lengths, as may be seen in the background. Each of these lengths is stretched out upon the testing bench and compared with a standard 10-foot length of the same pitch. If it agrees within the required limits, one end is held by a hook

at the end of the bench and the other end attached to the testing apparatus shown. The main lever of this device is studded with pin holes, and by means of a pin and different weights the required testing pressures can be applied to the various sizes of chain. It is then again compared with the standard to detect stretching. As the chain is drawn from the reels, it is pulled through a series of sprockets to discover any stiff or otherwise faulty links that may be in it.

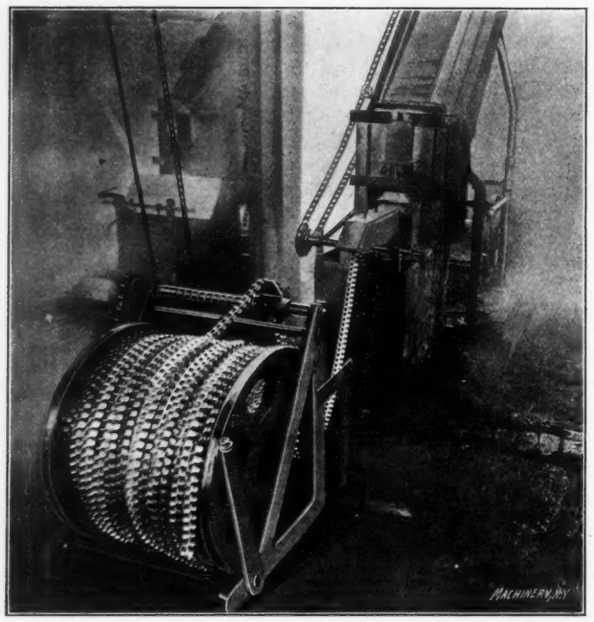

Fig. 6. Chain passing from the Reel into the Hardening Furnace

Each and every link undergoes this exacting examination, and, as two men will put 20,000 feet of the chain through the various tests in one day, the process is not as slow as it would at first seem.

It is not necessary to apply oil to the chain prior to shipment, as the oil tempering operation leaves the chain with a film of oil, baked on, which not only protects the steel from

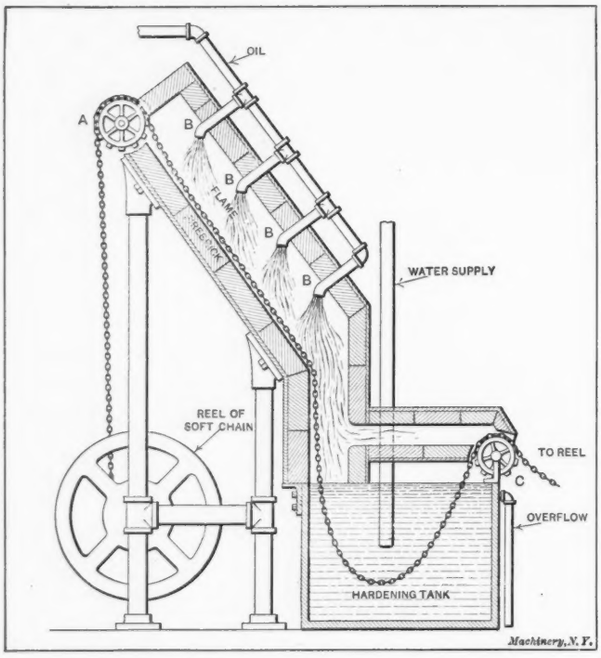

Fig. 7. Sectional View of the Automatic Hardening Furnace

the action of air and water, but gives the chain a durable glossy black finish that satisfactorily completes the manufacture of a superior sprocket chain.

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A new aviation prize, offered by the French paper *Matin*, consists of a sum of $20,000 which will be paid for the first flight with an aeroplane from "city to city" before Aug. 1, 1910.

APPLICATION OF ELECTRICITY FOR PURIFYING AIR

New applications of electricity are being discovered daily but not every new application is of as much interest or importance as one recently developed for purifying the air of reading rooms, theaters, and other close places where large numbers congregate. The apparatus referred to is the ozone generator made by the National Air Filter Co., Chicago, a large installation of which was recently made in the Chicago Public Library to purify or ozonize the 10,000 cubic feet of air per minute that is forced into the main reading room. Dr. W. A. Evans, health commissioner of Chicago, declared that the air in the library building prior to the installation of the apparatus was entirely unfit for use, being foul and dangerous, and probably no other building in the city has been subjected to more condemnation because of its defective ventilating system than it. After the installation of the ozonizing apparatus it was found that the main reading room was completely deodorized, the air being freed of that disagreeable and deleterious odor which for years had so thoroughly permeated all papers, books, furnishings, etc., in this large room. The fresh sterilized "mountain" air in the room reduced the humidity during the hot, oppressive days of summer, and greatly increased the comfort of the readers and employes. The installation renders the disinfecting of all books, periodicals, papers, etc., on the shelves, racks, tables, etc., an automatic process, keeping them constantly in a hygienic condition.

Fig. 8. Department where the Chain is tested

The ozone generator is installed in the large air duct and measures 6 feet high, 11 inches thick and 1 foot wide; it consumes 6.5 amperes of current per hour while ozonizing 15,000 cubic feet of air per minute. A connection is made with a feed wire of 110 volts to a step-up transformer which discharges a current at a potential of 7,000 volts. The high-tension current feeds into a series of electrodes made in the form of ordinary hairbrushes. A static electrical discharge is maintained playing against a series of glass plates. Through this blue electrical discharge of 7,000 volts, air is forced, the result being that all bacteria, germs, etc., are electrocuted. When the filtering electrodes become dirty or clogged they are simply rubbed together and cleaned as one would clean an ordinary hair brush. The generator is placed between the fan and the spray of water used in washing the air, to prevent losing the ozone which the water would otherwise naturally take up.

The low consumption of current and consequent low maintenance cost makes the ozone generator feasible for purifying the air of shops, mills and factories where difficulty is experienced in supplying air in large volume free from odors. It is of commercial importance for preserving and restoring food and other products affected by odors or quickly tainted by decay. Ozone has been found to completely deodorize stale milk, cream, butter and other creamery products, and other uses for the process are constantly being discovered. It is being used for aging wine, curing tobacco, tanning hides, purifying water, etc.

CALCULATING THE SIZE OF BLANK FOR ROLLING SCREW THREADS

J. F. SPRINGER*

There are some interesting problems connected with screw threads which come into prominence when we take up the question of forming them, not by a cutting operation, but by a rolling process. In the process of thread rolling there is no cutting of the groove; the whole procedure depends upon pressing the metal down at one point and permitting it to protrude at another. There are no chips. The amount of metal with which one begins is the amount with which one ends. When cutting a thread in the lathe, the gage of the thread is the same as the gage of the blank; but this is not the case in thread rolling. The thread here projects out be-

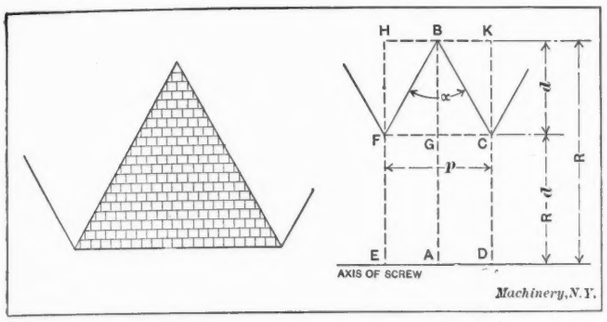

Fig. 1

Fig. 2

yond the original surface, so that to make a screw thread of a particular gage, it is necessary to use a blank of less diameter. But how much less? To answer this question, it is necessary to determine just how much material is contained in a screw thread.

Before taking up this question in a mathematical way, it may be well to point out how it might be solved experimentally. Suppose we wish to ascertain the exact volume of a sharp 60-degree V-thread ¾ inch in diameter, 10 threads per inch. Taking a ¾-inch rod of some homogeneous material, we first weigh it accurately. We next cut the required thread in the lathe, and measure the length of rod thus threaded. We may now weigh the rod again. The difference between this weight and the former one is evidently the weight of material removed in forming the groove. To get the weight of the thread itself, we may now turn off the threads and weigh the rod after the threads have been turned off. Still another method of getting the volume of the thread depends upon the fact that the groove and thread combined form a cylindrical shell whose volume may easily be calculated (by subtracting the volume of the cylindrical core from that of the blank before threading). Therefore, when once we have ascertained the volume of groove or thread, the volume of the other may readily be obtained from the combined volume by subtraction. All methods of cutting and weighing, however, require very delicate scales and careful experimentation; besides, they have to be repeated for every size.

It is important, then, to consider how we may approach this subject mathematically. The simplest thread to calculate is the square thread. In this thread the amount of metal removed is exactly the same as that left in the thread. Consequently, to get the volume of either thread or groove, we calculate the volume of the cylindrical shell, between the core of the bolt and the original cylinder of the blank, and then divide by 2. Suppose the diameter of the blank is 2 inches and the depth of thread is 0.2 inch. Then the radius of the blank is 1 inch, and that of the core 0.8 inch. If the length of the threaded portion is 3 inches, we have for the shell:

$\pi \times 1^2 \times 3 - \pi \times 0.8^2 \times 3 = 3.393$ cubic inches.

As thread or groove is one-half the shell, we have, for either, the value 1.697 cubic inch.

If there are eight threads to the inch, then there are altogether in the three inches of length a total of 24 threads. Consequently, the volume of a single thread passing once around the screw is $\frac{1.697}{24} = 0.071$ cubic inch.

Now let us consider the case when square grooves and square ridges run around the bolts in planes perpendicular to the axis. Just as before, the volume of the ridges is just equal to that of the grooves, provided that ridges and grooves are the same in section. We must, however, have an equal number of grooves and ridges in order to calculate correctly. In three inches we should have 24 ridges and 24 grooves. Consequently, as before, we find that a single ridge or groove has a volume at 0.071 cubic inch. Consider now what this means. Provided the cross-section is the same in both cases, a square thread has the same volume whether the thread is a ridge in a plane at right angles to the axis or whether it winds as in a screw. This is a very important conclusion, as upon it depends our method for the calculation of other styles of threads. It does not matter, then, how much or how little a square screw thread is inclined, its volume is ever the same, provided no change in the axial section is made. To determine its volume, accordingly, we take it in its easiest position—that is, when it is a plain annular band. We can easily calculate this, by finding the volume of a cylinder whose base has the same diameter as the thread and whose height is one-half the pitch. From this we subtract the volume of the cylinder whose height is one-half the pitch and whose diameter is that of the thread less twice the depth of the thread. The difference between these two volumes will be the volume of one thread passing once around the screw. Let $2R$ be the diameter of the original blank, p the pitch, and d the depth of thread. If we denote the volume of one convolution of square thread by V, we may write

$$V = \frac{1}{2}\left[\pi R^2 p - \pi (R-d)^2 p\right] = \frac{1}{2}\pi p (2Rd - d^2) \quad (1)$$

Let us now inquire whether this principle that the volume of a convolution is independent of the inclination of the thread is true for the ordinary V-thread. In Fig. 1 is represented in axial section a 60-degree V-thread. We may divide this triangle by a series of lines all parallel to the base and equally distant from one another. We further divide the several bands into which the triangle is thus divided by vertical lines

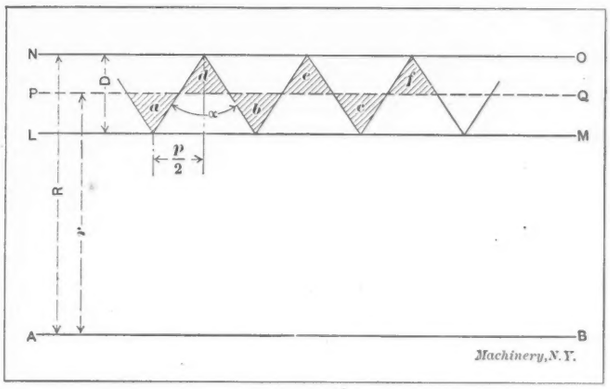

Fig. 3

into small squares all equal to each other. We have as the result a multitude of square screw threads. With the exception of the helical strips, one at the summit and one at each end of a row of squares, the cluster of little square threads will make up the large V-thread.

We now proceed to reduce the size of the section of the little square threads. Each one is made smaller, but each is kept square and all are kept equal. To do this, all we have to do is to draw all the lines closer together. The sum of the squares is now more nearly equal to the V-section, and the cluster of the small square threads becomes more nearly equal to the V-thread. If we continue to make the squares smaller, we get closer and closer to the V-section, and the cluster of square threads gets closer and closer to the V-thread. As there is no limit to our process of reducing the squares and, therefore, no limit to the closeness with which the resulting cluster of square threads approximates the V-thread, we conclude that the rule for square threads holds

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for the full V-section and the full V-thread. That is to say—we conclude that the volume of a V-shaped convolution may be found by ascertaining that of an annular ring having the same V-section. This is a very important conclusion.

A little consideration will soon convince one that precisely the same rule applies to any style of thread. For, by the same system of approximation, we may reach the same result.

Let us now derive the formula for the volume of a sharp V-thread. In Fig. 2, let a be the angle of the thread, p the pitch, d the depth, and R one-half the outside diameter. We must calculate the volume of an annular ring having the triangle BCF as its axial section. The volume of the annular ring may be determined by adding together the two conical frustums generated by rotating $ABCD$ and $ABFE$ on ED as axis and then subtracting the cylinder generated by rotating $FCDE$ on the same axis. We may write:

Frustum $ABCD =$

$1/3 \times 1/2\ p\ [\pi R^2 + \pi (R - d)^2 + \pi R (R - d)]$.

Frustum $ABFE =$

$1/3 \times 1/2\ p\ [\pi R^2 + \pi (R - d)^2 + \pi R (R - d)]$.

Cylinder $FCDE = p \pi (R - d)^2$.

Consequently, denoting the volume of the convolution of the screw thread by W, we have

$$W = \frac{p\pi}{6}[R^2 + (R-d)^2 + R(R-d)] + \frac{p\pi}{6}[R^2 + (R-d)^2 + R(R-d)] - p\pi(R-d)^2$$

$$= \frac{p\pi}{6}[2R^2 + 2(R-d)^2 + 2R(R-d) - 6(R-d)^2]$$

$$= \frac{p\pi}{6}[2R^2 + 2R^2 - 4Rd + 2d^2 + 2R^2 - 2Rd - 6R^2 + 12Rd - 6d^2]$$

$$= \frac{p\pi}{6}[6Rd - 4d^2],\ W = \frac{p\pi}{3}[3Rd - 2d^2)$$

$$= \frac{pd\pi}{3}[3R - 2d] \qquad (2)$$

We may put this formula in a different form. By referring to Fig. 2, we may write

$$\tan\frac{a}{2} = \frac{GC}{BG} = \frac{\frac{1}{2}p}{d} = \frac{p}{2d}, \text{ or } p = 2d\tan\frac{a}{2}.$$

Substituting this in equation (2), we get

$$W = \frac{2d^2\pi\tan\frac{a}{2}}{3}[3R - 2d] \qquad (3)$$

Since $\tan 30° = \frac{\sqrt{3}}{3}$, we have for the sharp 60-degree thread:

$$W_1 = \frac{2d^2\pi 1/3\sqrt{3}}{3}[3R - 2d]$$

$$= \frac{2\sqrt{3}}{9}d^2\pi[3R - 2d] \qquad (4)$$

Now, just as we found the volume of a convolution of the thread by adding two frustums and then subtracting a cylinder, so we may proceed with the calculation of the volume of a convolution of the thread groove. But we may take a different course; we observe that a thread convolution plus one of its adjacent groove convolutions has a volume equal to that of an annular ring whose axial section is the sum of those of thread and groove. By taking one-half of one adjacent groove and one-half of the other, we may reduce the annular ring to a cylindrical ring whose axial section is $FCKH$ (Fig. 2). The volume of this ring is obtained by subtracting the cylinder formed by rotating $EFCD$ from that formed by rotating $EHKD$. That is, the volume of the ring is $p\pi R^2 - p\pi(R-d)^2 = p\pi(2Rd - d^2) = pd\pi(2R - d)$. If we subtract from this the volume of the thread (equation 2), we get for the volume X of a convolution of the V-shaped thread groove,

$$X = pd\pi(2R - d) - \frac{pd\pi}{3}(3R - 2d)$$

$$= \frac{pd\pi}{3}(3R - d) \qquad (5)$$

Since $p = 2d\tan\frac{a}{2}$

we have

$$X = \frac{2d^2\pi\tan\frac{a}{2}}{3}(3R - d) \qquad (6)$$

For the sharp 60-degree thread, we have

$$X_1 = \frac{2\sqrt{3}}{9}d^2\pi(3R - d) \qquad (7)$$

It is interesting to note that with V-shaped threads, where the grooves have equal but inverted sections, the volume of a groove convolution is greater than that of a thread convolution. Thus the groove convolution is (formula (5))

$$\frac{pd\pi}{3}[3R - d]$$

and the thread convolution (formula (2))

$$\frac{pd\pi}{3}(3R - 2d)$$

The first value is greater than the second. By subtracting, we ascertain that the excess of groove over thread is $\frac{pd^2\pi}{3}$.

In rolling a screw thread, a sharp ridge is pressed into the blank. As the metal being operated upon is not easily compressible, particles move away from the advancing tool, penetrating, under the pressure applied, into the body of the blank; but they cannot coalesce with the particles against which they press; nor can they sensibly find room through compression. Thus it comes about that a sharp ridge pressed into a steel blank accomplishes two results First, it makes an indentation or groove. Second, it forms, indirectly, two adjoining ridges with a groove between them. Without going further into the process of thread rolling, enough has been said to make it clear that in threading a blank, the lower part of the groove is made by pressing suitable tool edges into the blank, and the upper part of the thread is due to material forced up out of the blank. Disregarding minute quantities, this bottom portion of the groove must equal in volume the extruded material. In Fig. 3, AB is the axis of the blank, PQ represents its original surface, LM marks the depth to which there is actual penetration of the forming dies, and NO defines the height to which there is extrusion of material. The problem that has to be solved is to determine $2r$, the diameter of the blank, when $2R$, the diameter of the desired screw, is given. The volume, then, of the grooves a, b, c, etc. must just equal the volume of the threads d, e, f, etc. By formula (3) we may express the volume of a convolution of the thread def. We replace d in this formula by its equivalent $R - r$, and obtain volume of thread convolution e (see Fig. 3).

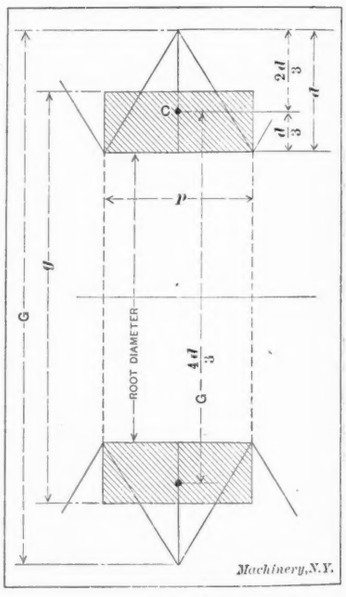


Fig. 4

$$e = \frac{2(R-r)^2\pi\tan\frac{a}{2}}{3}(R + 2r)$$

Similarly, by formula (6) we may express the volume of a convolution of the groove b; we must, however, replace R in this formula by r, and d by $D + r - R$ (see Fig. 3). We then have:

Volume of groove convolution

$$b = \frac{2\,(D+r-R)^2\,\pi \tan\frac{\alpha}{2}}{3}\,(2r - D + R)$$

Now thread convolution e must be equal to groove convolution b.

$$\frac{2\,(R-r)^2\,\pi \tan\frac{\alpha}{2}}{3}\,(R + 2r) = \frac{2(D + r-R)^2\,\pi \tan\frac{\alpha}{2}}{3}\,(2r-D + R)$$

or $(R-r)^2\ (R + 2r) = (D + r-R)^2\ (2r - D + R)$.

From this we get, after performing the operations indicated and collecting

$$3\ Dr^2 = D^3 - 3\ D^2R + 3\ D\ R^2.$$

Dividing by $3\ D$,

$$r^2 = \frac{D^2 - 3\ D\ R + 3\ R^2}{3}$$

$$r = 1/3\ \sqrt{3\ (D^2 - 3\ D\ R + 3\ R^2)}. \qquad (8)$$

It will, perhaps, be more convenient to have this formula in terms of R and p instead of in terms of R and D. Referring to Fig. 3, we see at once that

$$D = \frac{p}{2}\cot\frac{\alpha}{2}$$

Replacing, by means of this value, the quantity D in formula (8), we get,

$$r = 1/3\ \sqrt{3\left(\frac{p^2}{4}\cot^2\frac{\alpha}{2} - 3/2\ Rp\cot\frac{\alpha}{2} + 3\ R^2\right)}$$

$$r = 1/6\ \sqrt{3\left(p^2\cot^2\frac{\alpha}{2} - 6\ Rp\cot\frac{\alpha}{2} + 12\ R^2\right)}$$

If $\alpha = 60$ degrees, then $\cot\frac{\alpha}{2} = \sqrt{3}$,

and we get,

$$r = 1/6\ \sqrt{3\ (3\ p^2 - 6\ \sqrt{3}\,Rp + 12\ R^2)}$$

$$r = 1/2\ \sqrt{p^2 - 2\sqrt{3}\ R\ p + 4\ R^2} \qquad (10)$$

Formula (10) applies to the ordinary sharp V-thread of 60 degrees. The value $2r$ would be the diameter of wire that should be used on a thread rolling machine to produce a screw thread of an external diameter equal to $2R$. Let g be the diameter of blank wire and G the diameter of the finished screw thread. Then we may write,

$$g = \sqrt{p^2 - G\ p\ \sqrt{3} + G^2}. \qquad (11)$$

[The final formula above may be obtained in a simpler manner as follows: In Fig. 4, let

G = the outside diameter of thread,
g = diameter of blank,
d = depth of thread, and
p = pitch of thread.

The volume of one thread convolution equals the area of its section multiplied by the length of the path of the center of gravity of the section, if the section be rotated once about the axis of the screw. The center of gravity of a triangle is located one-third of its altitude from the base. Hence, C is the center of gravity, and the path of C when the thread section is rotated is a circle with the diameter $(G - \frac{4\,d}{3})$

The volume of the thread convolution then is

$$(G - \frac{4\,d}{3})\ \pi \times \frac{pd}{2}.$$

This volume must equal the volume of a hollow cylinder having an outside diameter equal to the diameter g of the blank, an inside diameter equal to the root diameter $(G - 2\,d)$ of the thread, and a height p (see Fig. 4).

Thus

$$\left(G - \frac{4d}{3}\right)\pi \times \frac{pd}{2} = [g^2 - (G - 2d)^2]\ \frac{\pi p}{4}$$

Solving for g^2 in this equation gives us

$$g^2 = \frac{4\ d^2}{3} - 2\ G\ d + G^2$$

or

$$g = \sqrt{\frac{4\ d^2}{3} - 2\ G\ d + G^2}$$

But for a 60-degree thread $d = p \times \cos 30° = \frac{p\sqrt{3}}{2}$.

Therefore, for a 60-degree thread

$$g = \sqrt{p^2 - G\ p\ \sqrt{3} + G^2}$$

This formula is the same as the one already found by the author's method.

While this formula is theoretically correct, it should be remembered that in thread rolling a great many factors enter which cannot be determined with absolute exactitude. Minute inaccuracies in the thread rolling tools, for instance, lack of homogeneity in the material, etc., would influence the size of blank required. The formula, however, will furnish a guide for selecting the approximate size of stock for thread rolling, although the final determination may have to be left to practical experiments.—EDITOR.]

* * *

HINDERING RECLAMATION WORK IN THE WEST

The reclamation work of the United States government in the arid regions of the West is done under the provision of the Reclamation Act which provides that the land benefited by the water provided shall be assessed for the cost of the work. The payment is made, not into the general fund of the United States Treasury, but into a special fund for reclamation work, and it again becomes available for further reclamation work in other sections.

The reclaiming of the arid regions was begun extensively under ex-President Roosevelt and his Secretary of the Interior, James Garfield. During the Roosevelt regimé settlers were permitted to work on the irrigation projects and the payment for the work was applied to offset assessments on their claims. This practice obviously was mutually beneficial to the settlers and the government. The settlers were able to employ their time profitably while waiting for the life-giving water and the government benefited inasmuch as it received payment on the assessments in advance, thus enabling other irrigation work to be begun long before it would have been possible had the settlers been obliged to wait for the returns received from the irrigated land before making payments.

Under the Taft-Ballinger regimé, the practice of applying the payments for work done by the settlers on future assessments has been stopped, because of an interpretation of the practice placing the government in the light of a debtor to the settlers for the work done on the projects. The *Engineering News* published a long editorial in its September 30 issue calling attention to the misrepresentation of an editorial in the *New York Times* accusing the Roosevelt Secretary of the Interior of being a socialist, etc. The *Engineering News* points out that the irrigation work, which is of enormous extent, has been done most efficiently and without the suspicion of graft, and it hints that this hindrance of further irrigation work is not in the interest of the general public. It is a pity that governmental red tape unwinding should be permitted to slow down one of the greatest projects ever undertaken for the common good.

* * *

The Department of the Interior of Canada has recently been estimating the available water power of the Dominion, and it is stated that there is 26,000,000 horse-power available in accessible localities, of which only 500,000 has hitherto been developed.

COMPRESSOR DESIGNING—THE DISTRIBUTION OF THE LOAD

FRANK RICHARDS*

The air compressor shown in Figs. 1 and 2 may be regarded as a standard machine for the special line of work for which it is adapted. There is that which is picturesque for the engineer as well as for the landscape gardener, and this is a picturesque and interesting machine, embodying a number of details of ingenious design which are well worth considering. The compressing of air is not in any case as simple an operation as the pumping of water, and when high pressures are required, involving, as in this case, multiple stage compression, the problem of equitably apportioning the work and the effect for each step of the operation, the providing for the easy flow and the efficient cooling of the air between the stages, the reduction of machine friction to a minimum, the providing for the proper lubricating of all the working parts, the arranging of all for ready accessibility when wear or accident makes it necessary, constitute in all an intricate problem, the solution of which is well worth looking into. Nothing, of course, is final, and everything achieved is a challenge to surpass it, so that doubtless later there may be a better machine than this, or than any we now know of, and we must note its points of excellence while we may.

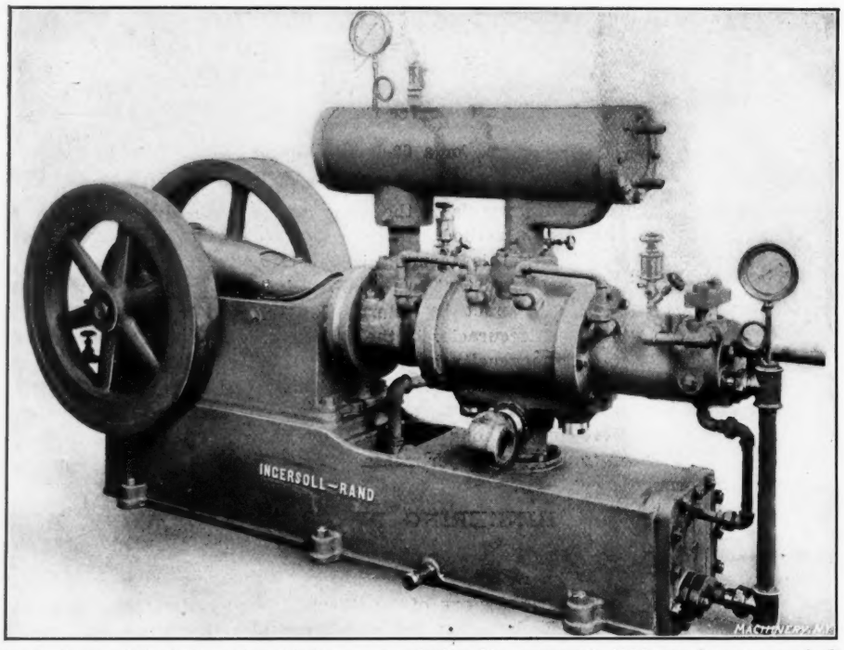


Fig. 1. Ingersoll-Rand Three-stage Air Compressor, designed to compress to 1000 pounds per square inch

This is a three-stage air compressor designed to work to 1,000 pounds gage pressure, with a free air capacity of about 50 cubic feet per minute. It is a power-driven machine, the type of power application being according to circumstances. As here shown it has a pulley for a belt drive, but it may also be driven by a chain, gearing, a Pelton wheel on an extension of the shaft, or by a direct-connected electric motor.

The dimensions of the cylinders are: 8-, 5- and 2⅜-inch diameter, respectively, by 8-inch stroke, and the normal speed is 150 revolutions per minute, giving a piston speed of 200 feet. The low-pressure, or intake, cylinder is double-acting and the other two are single-acting. The three cylinders are in a straight axial line, one piston-rod extending from the crosshead through all the pistons. The low-pressure cylinder is between the other two, the intermediate cylinder being in front, or toward the crank, and the high-pressure cylinder at the back. The pistons of the intermediate and of the high-pressure cylinder are, in fact, plungers on each side of the low-pressure piston. The working area of the low-pressure piston on each side is, therefore, only that portion of the piston which surrounds the plungers, and these areas are quite different on the two sides of the piston on account of the different plunger diameters. This arrangement gets rid of all cylinder heads or partitions and stuffing-boxes between the cylinders. The only stuffing-box for the entire machine is that in the head next to the crosshead and opposed to the working pressure of the intermediate cylinder. The piston rings are the only packings required besides this one stuffing-box. The packing rings for the low-pressure and the inter-

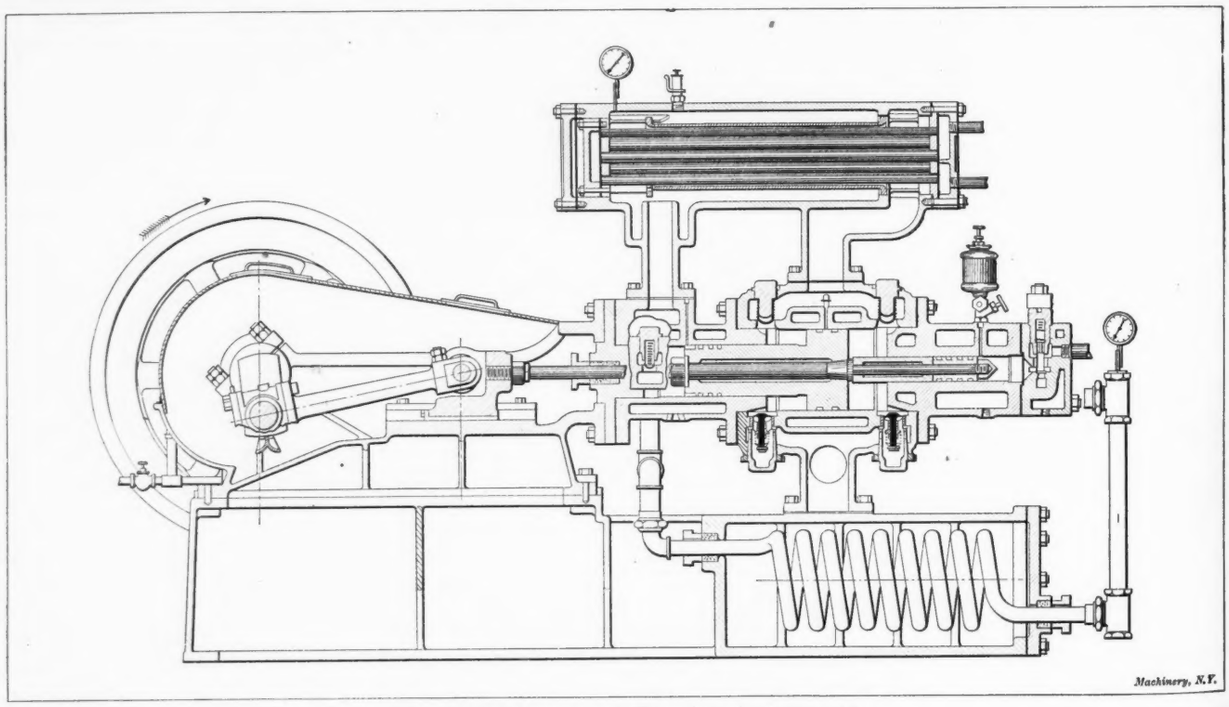


Fig. 2. Sectional View of the Three-stage Air Compressor

* Address: 229 W. 135th St., New York.

mediate pistons are sprung into grooves turned in the solid metal. In the high-pressure piston or plunger the grooves are not turned in the solid but are formed by removable sections which fit the piston-rod and also the cylinder bore, and which are cut away at the outer corner to form the grooves for the rings. When the main portion of this piston is in place in the cylinder, a packing ring is slipped in to fit against it; one of the movable sections of the piston is then slipped in against this, then another ring, then another piston section with a washer and nut outside, which secures all. The middle or low-pressure piston has a taper fit on the rod, and is secured by a nut outside the intermediate plunger, which thus locates it precisely and holds it securely.

The actual working clearances of one of these compressors, as determined by the inspector, were: for the low-pressure cylinder, 3/32 inch and 3/32 inch; intermediate cylinder, 1/8 inch; high pressure, 1/8 inch. The distribution of the pressures and the apportionment of the work of compression throughout the cycle of operations of this compressor are such as to make the work for each stroke nearly the same.

On the forward stroke, or with the pistons moving toward the crank, the low-pressure piston and the intermediate piston are both compressing to their respective pressures, and the receiver pressure against the high-pressure plunger is assisting; that is, its thrust at practically constant pressure is to be deducted from the total work done by the other two pistons. On the backward stroke, the low- and the high-pressure pistons are compressing, and the receiver pressure against the intermediate piston is assisting in the work. By calculation based on the assumption that the compression is adiabatic, it is found that the horse-power required for the forward compression stroke of the low-pressure cylinder is 2.79, and for the same stroke of the intermediate cylinder, 8.52 H.P. The total horse-power resistance for the forward stroke is 8.52 + 2.79 = 11.31 H.P. The intake pressure against the high-pressure plunger which is approximately constant, is sufficient to develop 3.13 H.P. which is to be deducted from the working horse-power of the other two cylinders, giving us as the net horse-power for the forward stroke 11.31 — 3.13 = 8.18 H.P. For the back stroke of the low-pressure piston the horse-power resistance equals 4.17 H.P., which is, of course, greater than for the forward stroke, because of the increased piston area. The resistance for the working stroke of the high-pressure cylinder equals 8.93 H.P., giving a total for both the low- and high-pressure cylinders of 4.17 + 8.93 = 13.10 H.P. From this it is necessary to deduct the power due to the intake pressure against the intermediate piston, which is found to be 3.13 H.P. The net power for the back stroke then will be 13.10 — 3.13 + 9.97 H.P.

While the work of the two strokes is so nearly equal, that of the back stroke is the larger, which is at it should be, as this occurs on the thrust of the connecting-rod instead of on the pull. A sufficient reduction of the terminal delivery pressure would equalize the work for the alternate strokes.

As before stated, adiabatic compression is assumed in each cylinder, with efficient intercooling between the stages. The cylinders are all very completely water jacketed, so that the temperatures of the working surfaces are kept down, and satisfactory lubrication is maintained, but there is little cooling effect upon the body of air in the cylinders during the operation of compression. The circulation of the cooling water is accomplished by a single continuous flow through both intercoolers and all the water-jackets, there being no places where the water can remain without change. The efficiency of the intercooling is sufficiently indicated by the fact that the temperature of the air leaving the second intercooler and entering the last compressing cylinder was found upon a prolonged test to be the same as that of the initial intake or 70 degrees, and the temperature of the air as finally delivered, there being no after cooler, was 188 degrees. The final temperature for perfect adiabatic, single stage compression to 1,000 pounds would be above 1,250 degrees, which would be prohibitive in practice.

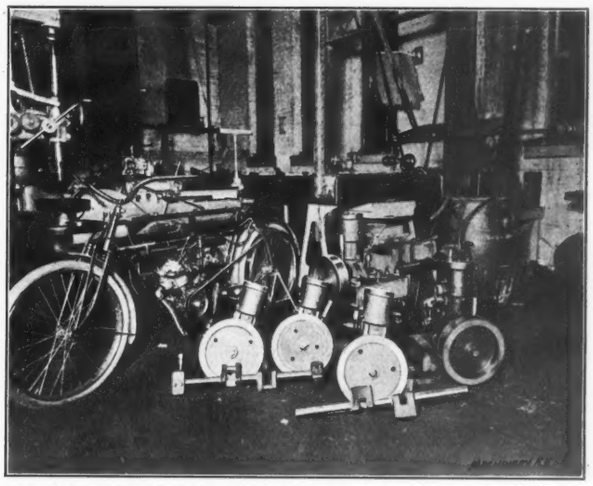
In a test which was made of one of these machines, in which the number of strokes of the compressor required to fill a receiver of known capacity was ascertained, the volumetric efficiency of the compressor, or the ratio of the volume actually delivered to the total piston displacement of the low pressure cylinder, was determined to be 0.927.

This compressor considered in detail will be found to be an extremely simple one when the complication of function is allowed for. The main frame combines in itself all the particulars upon which perfect and maintained alignment depends. The first cylinder has a true seat against the frame and the other cylinders successively locate themselves by their seating, all the joints being scraped and the faces going together without packing. Every valve is independently accessible by the removal of its cap. Taking off the high-pressure cylinder (which is no more work than the removal of a cylinder head) makes all the pistons easily removable, and gives complete access to all the cylinder interiors.

* * *

SHOP WORK AT THE UNIVERSITY OF WISCONSIN

As a rule, students graduate from engineering colleges with but a faint idea of modern machine-shop practice. They are often hastened through their required shop work by incapable instructors, who are only too willing to get them off their hands. To offer the students an interesting and instructive class of work, Mr. Paul Sladky, instructor in mechanical practice at the University of Wisconsin, designed last year a small, two-cycle gasoline launch motor. The accompanying engraving shows several of these engines. One of them is mounted on a testing rack, which consists of a propeller working in a barrel of water, enabling the engine to be tried out under almost actual working conditions. Fifteen of these engines were built the last school year by students who had no shop experience, except the work required by their respective courses. Three single and two double engines are now in almost daily service on Lake Mendota, Madison, Wis., giving excellent satisfaction. The cylinder is 3½ inches in diameter with a 4-inch stroke. The cylinder and head are integral, the crank case and side plates separate. The crank-shafts are forged at the university shop from machine steel billets and are machined with a special lathe fixture. By means of a distance piece, two cylinders may be connected to make a double engine.



Gasoline Engines built by the Students at the University of Wisconsin

To give the students instruction in the use, value and manufacture of interchangeable parts, jigs and fixtures are used wherever possible. In designing this engine, Mr. Sladky endeavored to make it as simple and durable as possible, and yet require neat and accurate work on all the different machine tools. So much interest has been taken in this class of work that Mr. Sladky is now designing a four-cycle engine to offer the students a choice of a number of sizes and types. The student buys the castings at cost and owns the engine when it is finished. He is obliged to test his engine himself, thus gaining by actual experience a knowledge of some of the gas engine troubles he is likely to meet in his future work.

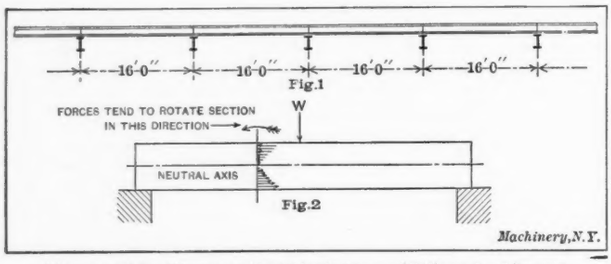
The engraving also shows a motor cycle, the engine of which was made by a junior mechanical engineer.

SPLICES FOR I-BEAMS AND CHANNELS*†

A. L. CAMPBELL‡

It often happens, in the use of rolled shapes for structural purposes, that the material could be spliced together conveniently and with economy, provided an efficient and reliable form of splice were available.

For example, Fig. 1 shows a side elevation of a long row of floor beams, supported every sixteen feet. In such a case the row of beams is usually made up of sixteen-foot lengths, supported on the cross beams, and with little or no connection between their ends. If the floor load is uniformly distributed, the maximum bending moment in the floor beams will be $\frac{WL}{8}$ at mid-span, where W is the total load on the beam per panel, and L is the panel length. Now, assume that the row of floor beams is shifted bodily eight feet to the left or the right, so that the beams will be continuous over the supports, with the ends butting together at mid-span; then, if the ends were efficiently spliced together, we would have a continuous floor beam, with maximum bending moments of $\frac{WL}{12}$ at the supports, and $\frac{WL}{24}$ at the splices. Thus, the bending moment in the floor beams is a maximum where their gross section is available to resist it, while the bending efficiency of the splice at mid-span need be only 50 per cent of the maximum.



Figs. 1 and 2. Diagrams for Calculations of Splices for I-beams

With the second arrangement the floor will safely carry a load 50 per cent greater than it would with the first, or for the same load only two-thirds as much material need be used in the floor beams. Long ties, etc., might also be made up of two or more pieces, with splices, thus saving double freight charges for shipping long pieces.

Splices for I-beams and channels have been calculated in the following, and the splices for the I-beams are also shown in the accompanying Supplement. The sections are taken from Carnegie's Hand-book, and a medium section of each size has been chosen. The calculations may, however, be readily applied to any desired section. In every case the splices for I-beams and channels consist of a top and bottom plate, or plates, riveted to the flanges, and two side plates riveted to the web.

The reason why medium-sized sections have been selected for the calculations, rather than the so-called standard sections, is that the medium-sized section more nearly fulfills the average requirements in design, and as the steel mills constantly roll other than the standard sections, they can be obtained without difficulty. An inspection of a table of steel shapes reveals the fact that the standard section is usually the lightest section rolled of any one size, and has a very thin web. If a short standard section be used as a beam, the load, which will produce a fiber stress of 16,000 pounds per square inch in a beam, will greatly overload the web of the beam over the supports, when it acts as a compression member. If one or more of these light sections be used as columns or struts their strength is limited to the crippling strength of their webs. For these reasons the engineering department of the firm where the writer is employed has adopted the medium weights of I-beams and channels as standard sections for average designs.

Having assumed a section to be spliced, it is first necessary to find what proportion of the total area of the section exists in the flanges, and what is contained in the web. Then the splice is so proportioned that the strength of the beam will be, at that point, as nearly as possible equal to what it would be if no splice existed in it. The method of procedure when designing the splice will be illustrated in the following computations, in which the working stresses are assumed as follows:

Tension and compression, 16,000 pounds per square inch.
Shear, 10,000 pounds per square inch.
Bearing, 20,000 pounds per square inch.
Double shear is equivalent to 1.8 single shear.

Splice for 24-inch 90-pound I-beam (See Supplement)

Area of section, 26.47 square inches.
Thickness of web, 0.631 inch.
Width of flange, 7.131 inches.
Tangent of web, 20.75 inches (depth of flat portion of web).
Grip of rivet, 27/32 inch (depth of rivet holes in flanges measured on center line of holes).
Sectional modulus of section, 186.6 (neutral axis perpendicular to web).

As shown in the Supplement, the rows of rivets in the web are 2½ inches apart; thus each row may be regarded as carrying a load equal to the stress in a strip of the web extending 1¼ inch above and below its center line. Since the distance from the top row to the bottom row of rivets is 18¼ inches, the portion of the web upon which the web rivets of the splice will be effective is 18¼ + 1¼ +1¼, or 20¾ inches, and the sectional area of this portion is 20¾ × 0.631, or 13.09 square inches. The area of the section to be cared for by the rivets in each flange, or the sectional flange area, is then $\frac{26.47 - 13.09}{2}$ or 6.69 square inches.

Having now found the flange and web areas of the above section, it is only necessary to so proportion the rivets in the splice that the existing fiber stresses in the beam may be transferred into the splice plates, and to provide ample metal in these plates to prevent excessive fiber stresses in them.

The net section of a strip of the web 2½ inches wide (one 15/16-inch hole deducted) is (2½ — 15/16) × 0.631 = 0.99 square inch, and the allowable tension on this strip will be 0.99 × 16,000 = 15,840 pounds. Allowable double shear of a ⅞-inch rivet = 1.8 × 6,010 = 10,818 pounds, while its bearing value in the web is ⅞ × 0.631 × 20,000 = 11,060 pounds. The number of rivets required in the web plates for each strip is therefore 2.

The net section of the flanges will be 6.69 — 2 × 27/32 × 15/16 = 5.11 square inches, and the allowable stress on this area will be 5.11 × 16,000 = 81,760 pounds. The number of ⅞-inch rivets in single shear required to transmit this stress to the flange plates is 14. The web plates should have a combined thickness greater than the thickness of the web, so two ⅜-inch plates are used. In like manner two ½ × 7⅛-inch plates will have a combined net area of 5.25 square inches, and may be used on both flanges.

The sectional modulus being 186.6, the maximum allowable bending moment in a beam of this section is 186.6 × 16,000 = 2,985,600 inch-pounds. At first, 14 rivets only are calculated for on each side of the center of the splice, in the flanges. Taking moments about the neutral axis of the beam and splice, for the rivets above or below this axis, we obtain the resisting moment for this portion of the rivets as follows:

$14 \times 6{,}010 \times 12 = 1{,}009{,}680$ inch-pounds.

$2 \times \frac{73}{96} \times 10{,}818 \times 9\frac{1}{8} = 150{,}128$ inch-pounds.

$2 \times \frac{53}{96} \times 10{,}818 \times 6\frac{7}{8} = 79{,}130$ inch-pounds.

$2 \times \frac{33}{96} \times 10{,}818 \times 4\frac{1}{8} = 30{,}679$ inch-pounds.

$2 \times \frac{13}{96} \times 10{,}818 \times 1\frac{5}{8} = 4{,}758$ inch-pounds.

Total resisting moment 1,274,375 inch-pounds.

* See also article entitled "Beam Formulas," MACHINERY, September, 1905, engineering edition, and MACHINERY's Data Sheet No. 48, Stresses and Deflections in Beams, Shafts, etc.
† With Data Sheet Supplement.
‡ Assistant Construction Engineer, The Solvay Process Co., Detroit, Mich.

The fractions whose denominators are 96 represent the ratios of the distances from the neutral axis, of the different rows of web rivets, and the product of this fraction multiplied by 10,818 is the actual working load of any one web rivet, when the flange rivets have assumed their maximum allowable load.

Since the forces producing tension and compression in the beam below and above the neutral axis tend to cause rotation in the same direction (see Fig. 2), the resisting moment of all the rivets on one side of the splice is twice the above amount, or 2,548,750 inch-pounds. The resisting moment

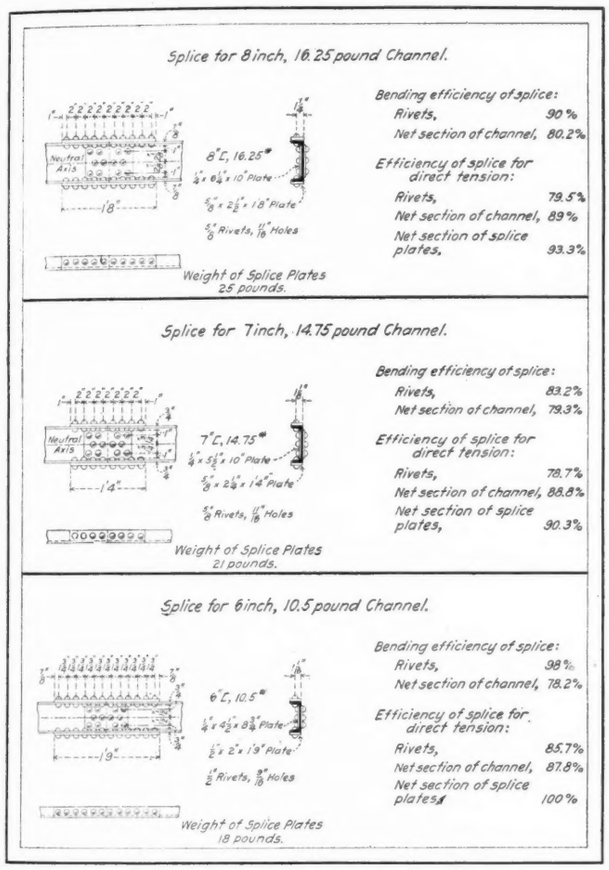

Splice for 8 inch, 16.25 pound Channel.
Bending efficiency of splice:
Rivets, 90%
Net section of channel, 80.2%
Efficiency of splice for direct tension:
Rivets, 79.5%
Net section of channel, 89%
Net section of splice plates, 93.3%
Weight of Splice Plates 25 pounds.
Splice for 7 inch, 14.75 pound Channel.
Bending efficiency of splice:
Rivets, 83.2%
Net section of channel, 79.3%
Efficiency of splice for direct tension:
Rivets, 78.7%
Net section of channel, 88.8%
Net section of splice plates, 90.3%
Weight of Splice Plates 21 pounds.
Splice for 6 inch, 10.5 pound Channel.
Bending efficiency of splice:
Rivets, 98%
Net section of channel, 78.2%
Efficiency of splice for direct tension:
Rivets, 85.7%
Net section of channel, 87.8%
Net section of splice plates, 100%
Weight of Splice Plates 18 pounds.

Fig. 3. Splices for 6-, 7- and 8-inch Channels

being always equal to the bending moment, the bending efficiency of the above splice with respect to the rivets is

$$\frac{2{,}548{,}750}{2{,}985{,}600} = 85.4 \text{ per cent.}$$

The point of minimum bending efficiency of the beam at the splice will be found at section AA, two rivet holes being here deducted from each flange. The transverse sectional area of these two rivet holes is 1.58 square inch, and the distance from the center of gravity of this area to the neutral axis of the beam is about $11\frac{5}{8}$ inches. The bending efficiency of the beam at section AA is therefore

$$\frac{2{,}985{,}600 - 2 \times 1.58 \times 16{,}000 \times 11\frac{5}{8}}{2{,}985{,}600} = 80.4 \text{ per cent.}$$

Since the minimum efficiency of the splice is the effective one, it is desirable to increase the strength of the beam by a rearrangement of the flange rivets. If one rivet is omitted from each flange at section AA, the bending efficiency of the beam will be increased, but that of the rivets in the splice will be reduced to 80.6 per cent. It therefore becomes necessary to leave two rivets in each flange at this point and add one extra rivet, as shown. Fifteen rivets are now effective in each flange, and the rivet efficiency for bending is 90 per cent. The least bending efficiency of the beam will still be found at section AA, and amounts to

$$\frac{2{,}985{,}600 - 2 \times 1.58 \times 16{,}000 \times 11\frac{5}{8} + 2 \times 6{,}010 \times 12}{2{,}985{,}600} = 85.2$$

per cent.

If the above spliced beam is placed upon supports at the ends in such a manner that the splice does not come exactly in the center between the supports, but so that the section AA comes between the center of the splice and the middle of the beam and yet is not more than 85.2 per cent of half the span from one of the supports, then, if loaded in the middle, this beam will be able to carry the same load as it would carry if the beam were in one piece. It is easily seen that for most, if not all, conditions of loading the above beam, the splice may be so located that the beam will be as strong as though no splice existed in it.

This splice is excellent for direct tension also. The point of minimum efficiency for a net section of the beam will be found at section AA, and will be

$$\frac{26.47 \times 16{,}000 - 2 \times 1.58 \times 16{,}000 + 2 \times 6{,}010}{26.47 \times 16{,}000} = 91.2 \text{ per cent.}$$

The efficiency of the rivets will be, with fifteen $\frac{7}{8}$-inch rivets in single shear in each flange, and sixteen $\frac{7}{8}$-inch rivets in double shear in the web,

$$\frac{30 \times 6{,}010 + 16 \times 10{,}818}{26.47 \times 16{,}000}, \text{ or } 83.7 \text{ per cent.}$$

The net section of the splice plates will have an efficiency, along the innermost row of rivets, equal to

$$\frac{2 \times \frac{3}{8}\,[6(2\,13/16 - 15/16) + (3\frac{1}{4} - 15/16) + (2 \times 1\frac{1}{4} - 15/16)] + 2[7\frac{1}{8} - 2 \times 15/16]}{26.47} = 82.4 \text{ per cent.}$$

In the design of this splice it has been assumed that the ends of the spliced beam do not butt tightly together. If

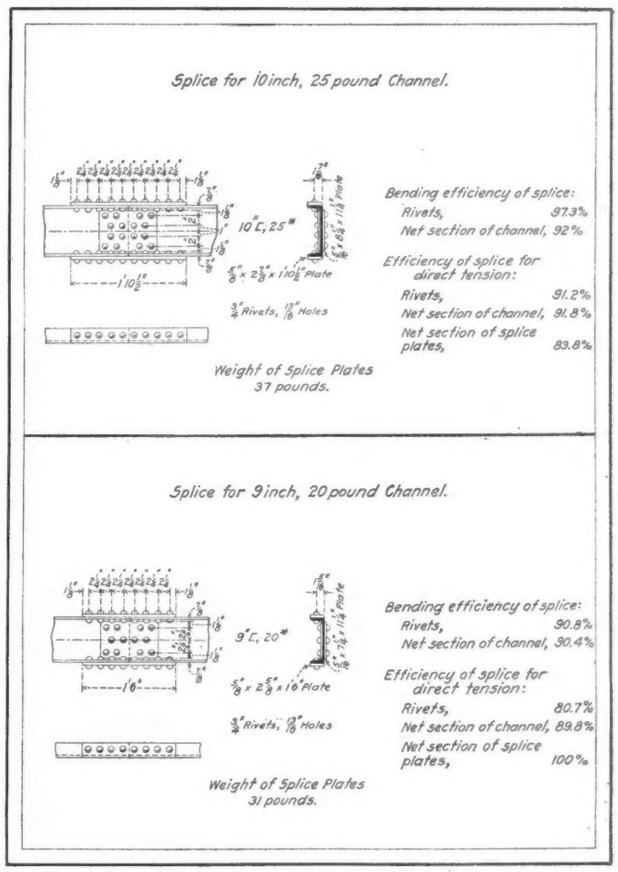

Splice for 10 inch, 25 pound Channel.
Bending efficiency of splice:
Rivets, 97.3%
Net section of channel, 92%
Efficiency of splice for direct tension:
Rivets, 91.2%
Net section of channel, 91.8%
Net section of splice plates, 83.8%
Weight of Splice Plates 37 pounds.
Splice for 9 inch, 20 pound Channel.
Bending efficiency of splice:
Rivets, 90.8%
Net section of channel, 90.4%
Efficiency of splice for direct tension:
Rivets, 80.7%
Net section of channel, 89.8%
Net section of splice plates, 100%
Weight of Splice Plates 31 pounds.

Fig. 4. Splices for 9- and 10-inch Channels

these ends were fitted together perfectly no splice plates would be needed on the compression half of the beam. Since a perfect bearing is impossible, at least the two web plates should extend to the top of the beam. The top flange plates may, however, be safely omitted when the ends are well butted together and a floor plate is riveted to the top flange.

Splice for a 20-inch 80-pound I-beam (See Supplement)
Area of section, 23.73 square inches,
Thickness of web, 0.6 inch,
Width of flange, 7.0 inches,
Tangent of web, 16.5 inches,
Grip of rivets, 29/32 inch,
Sectional modulus of section, 146.7.
Gross web area = $16.5 \times 0.6 = 9.9$ square inches.

$$\text{Gross flange area} = \frac{23.73 - 9.9}{2} = 6.92 \text{ square inches.}$$

The net flange area = $6.92 - 2 \times 15/16 \times 29/32 = 5.22$ square inches, and the allowable tension on this area is $5.22 \times 16{,}000 = 83{,}520$ pounds. The number of rivets required is

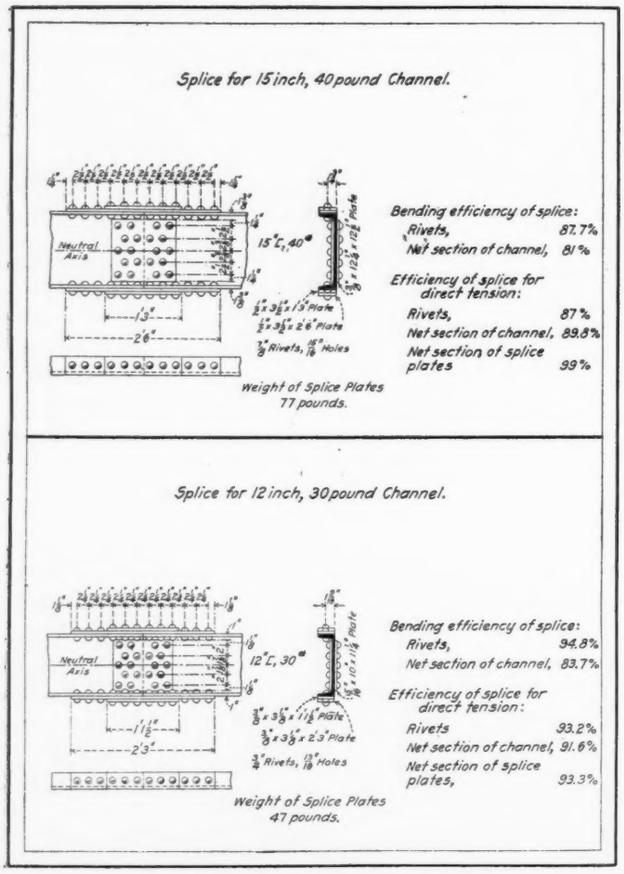

Splice for 15 inch, 40 pound Channel.
Neutral Axis
15"C, 40#
Bending efficiency of splice:
Rivets, 87.7%
Net section of channel, 81%
Efficiency of splice for direct tension:
Rivets, 87%
Net section of channel, 89.8%
Net section of splice plates 99%
Weight of Splice Plates 77 pounds.
Splice for 12 inch, 30 pound Channel.
Neutral Axis
12"C, 30#
Bending efficiency of splice:
Rivets, 94.8%
Net section of channel, 83.7%
Efficiency of splice for direct tension:
Rivets 93.2%
Net section of channel, 91.6%
Net section of splice plates, 93.3%
Weight of Splice Plates 47 pounds.

Fig. 5. Splices for 12- and 15-inch Channels

fourteen, but from the computations already made for the 24-inch I-beam it is seen that this number actually ought to be fifteen. Use one $\frac{5}{8} \times 7$-inch plate, and one $\frac{1}{2} \times 7$-inch plate, for each flange, and two $\frac{3}{8}$-inch web plates. As in the preceding case, each row of web rivets should contain two rivets.

The total resisting moment (twice the moment of the rivets above or below the neutral axis) of the rivets on one side of the splice is

$2 \times 15 \times 6{,}010 \times 10$	= 1,803,000	inch-pounds,
$2 \times 2 \times 7/10 \times 10{,}500 \times 7$	= 205,800	inch-pounds,
$2 \times 2 \times 9/20 \times 10{,}500 \times 4\frac{1}{2}$	= 85,050	inch-pounds,
$2 \times 2 \times 1/5 \times 10{,}500 \times 2$	= 16,800	inch-pounds,
Total resisting moment,	2,110,650	inch-pounds.

Note.—10,500 pounds is the bearing value of a $\frac{7}{8}$-inch rivet in the web. This amount is less than that of double shear.

The bending efficiency of the rivets is $\frac{2{,}110{,}650}{146.7 \times 16{,}000} = 90$ per cent.

The minimum bending efficiency of the net section of the beam will be found at section *BB*, two rivet holes being here deducted from each flange. The efficiency will be

$$\frac{2{,}347{,}200 - 2 \times 1.7 \times 9\frac{5}{8} \times 16{,}000 + 2 \times 10 \times 6{,}010}{2{,}347{,}200} = 82.8 \text{ per cent.}$$

When this splice is used in a tension member, the weakest part of the beam is at section *BB*, and the efficiency is

$$\frac{23.73 \times 16{,}000 - 2 \times 1.7 \times 16{,}000 + 2 \times 6{,}010}{23.73 \times 16{,}000} = 88.8 \text{ per cent.}$$

The rivet efficiency will be

$$\frac{30 \times 6{,}010 + 12 \times 10{,}500}{23.73 \times 16{,}000} = 80.7 \text{ per cent.}$$

The efficiency of the net section of the splice plates will be

$$\frac{2 \times \frac{3}{8}[4(2\,13/16 - 15/16) + (4 - 15/16) + (2 \times 1\frac{1}{4} - 15/16)] + 2\,[\,(7 - 2 \times 15/16) \times 1\frac{1}{8}]}{23.73} = 86.7 \text{ per cent.}$$

Splices for channels are designed in exactly the same manner as those for I-beams, so an explanation of details is unnecessary. It will be noticed, however, in the accompanying engravings, that the flange rivets are not located on the regular gage lines of the channel flanges, but as nearly as possible in the middle of the flange plates. This was done to avoid eccentric loads in these plates.

In the accompanying Data Sheet Supplement are shown splices for I-beams of various sizes, and in the accompanying illustrations are shown the splices for channels. The efficiency of the riveting, net section of the beam, etc., are also given in percentages.

Splices are not shown for I-beams and channels smaller than the 6-inch sections, because it is not often necessary to splice such small pieces; also, the efficiency of the splice would probably be low. The efficiencies of the above splices may be increased by modifying their details. For instance, it will be noticed that usually the least efficiencies are for the net section of the beam for bending, and for direct tension; and the rivet efficiency for direct tension. These values may be increased by using smaller flange rivets, and more of them. In general it may be said that the minimum efficiency of any of the above splices may be made as high as 85 per cent. Only one size of rivet is here used, however, since it is desired to make the details of these splices conform to standard practice as much as possible.

The writer has been unable to find any published data concerning the splicing of structural shapes; he has devised the above method of analysis and furnished designs of splices, with the hope that it may be of some use to others.

In conclusion, it is regretted that none of the above splices have ever been tested to destruction, so that no experimental data are available to confirm or disprove the correctness of the above analyses. However, a set of splices very similar to these was designed by the writer, for a large manufacturing firm in the middle West. These splices have been used continuously for the past two years on all classes of work. In no case have they given trouble, or showed signs of weakness, though often loaded to the full capacity of the pieces in which they occur. One of the most prominent examples is a 15-inch 60-pound I-beam, of 27-foot span, supported at the ends and uniformly loaded with about 500 pounds per lineal foot. This beam is spliced in the middle, and has deflected about one-fourth of an inch under the above load. The beam has deflected in a long smooth curve, showing that the bending efficiency of the splice is really high. If the splice were weak in proportion to the rest of the beam, the tension and compression on the bottom and top of the beam would localize at the splice; and the two halves of the beam would deflect as chords intersecting at the splice, instead of as an arc. Another good illustration is a tension member 116 feet long, composed of two 15-inch, 55-pound channels, and a 1 x 12-inch plate, carrying a load of 544,000 pounds at the middle. It contains six splices, all designed by the above methods, and has borne this load for about fifteen months, with no signs of weakness.

* * *

THE BENEFICENT TARIFF

Every family using iron ore, pig iron, scrap iron, steel rails, cash registers, linotypes, typewriters, steam engines, and wood pulp will now be able to buy them for less, and the cost of living will be reduced.—*New York Times.*

CHAPTERS IN THE EARLY HISTORY OF MACHINE TOOLS—3

JOSEPH G. HORNER*

In continuing the discussion of early types of machine tools, we shall take up in the present article the development of drilling and boring machines, the steam hammer, screw-cutting machinery and the primitive forms of gear-cutting and milling machines.

Slot Drilling Machines

Richard Roberts of Manchester is said to have invented the slot drilling machine as well as the slotting machine, but in 1847 Nasmyth designed a slot drilling machine to avoid the labor of cutting grooves by drilling, chipping and filing. The drill was, as now, flat ended with a notch at the center. The machine was provided with a work table having self-acting traverse, the length of which was adjusted by a crank and rod, and a down-feed put on automatically at the end of the stroke. The gain was stated to be ten to one, and a boy or laborer was given the task of attending to it. Nasmyth did not patent it, but "always had an abundance of orders, as it was its own best advertisement."

A Whitworth slot drilling machine of date 1867 is shown in Fig. 18, driven by a cone pulley and shaft at the back of the bed, through miter gears, and sliding horizontal and vertical shafts to the spur gear seen on the top of the spindle. This spindle runs in hardened conical bushings in a sliding octagonal ram. The spindle head is adjustable along the bed by hand to suit the position of the slot or cotter hole in the work. The reciprocating movement of the drill spindle is operated from the small three-speed cone pulleys seen on the bottom slide of the head. The front pulley is keyed to a worm shaft, rotating a worm wheel with a slotted disk, to which is attached a connecting rod, adjustable for length of stroke, the other end of which is fixed to the middle slide. The octagonal ram slide has a cross adjustment by hand, and the octagonal ram itself has a variable automatic and down feed at both ends of the stroke.

Drilling Machines

The drilling machine was early developed into essentially present designs, both fixed and radial. Back geared cone spindles, self-acting and counterbalanced drilling spindles, rack elevated tables and compound movements to tables, may

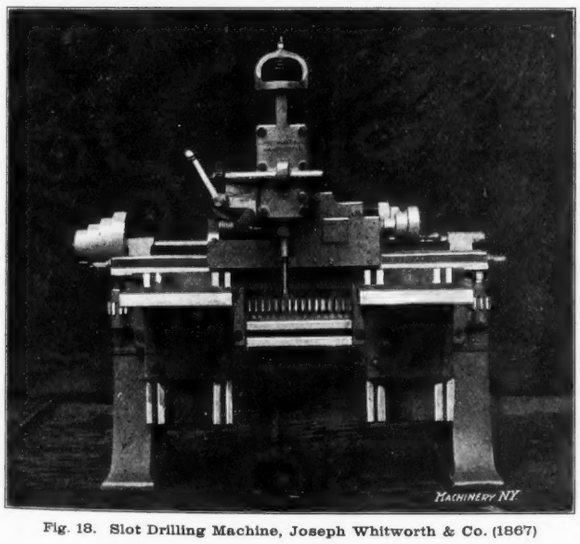


Fig. 18. Slot Drilling Machine, Joseph Whitworth & Co. (1867)

be noted in examples dating from 60 to 70 years back. The framings have a strangely skeleton like appearance, for the box framing had not then come into use.

There were radial drilling machines at Soho, the radial arm being capable of vertical adjustment on a round pillar, by means of a screw. The brackets which carried the pillar were bolted to the wall.

A boring and drilling machine at Soho was double back geared and provided with power and hand feed. It stood 25 feet high, its brackets being bolted to the wall, and the floor plate being movable along a bed 36 feet in length on the floor. It was used largely for boring the beams of the early engines.

In drilling machines made by Whitworth 60 or 70 years ago (Fig. 19) the worm-wheel feed was applied to the drilling spindles. The portion of the spindle above the splined driving bevel wheel and between it and the top bearing was threaded. Two worm wheels located on opposite sides engaged with the screw threads. The worm wheel journals worked in bearings, and the ends were prolonged to be em-

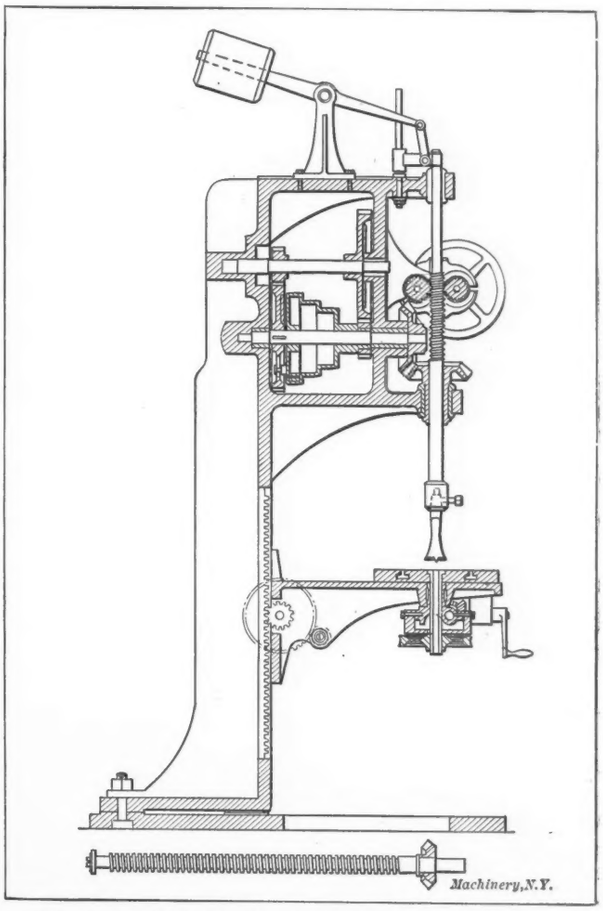


Fig. 19. Vertical Drilling Machine with Screw Feed and Worms Joseph Whitworth & Co. (About 1846)

braced by divided friction clips, Fig. 20, tightened or slackened by a vertical screw. When the clips were tightened so that the worm wheels could not revolve, the spindle screw was fed positively. If the clips were slackened to permit the wheels to slip moderately, the amount of feed was lessened. Probably this graduated feed was too uncertain in its action, but it seems to have been used frequently on radial as well as on fixed machines made by Whitworth.

In the forties we find drilling machines in which the spindle feed is imparted by a treadle and a lever at the top, counterbalanced, pressing the spindle downward by the movement of a bracket sliding on the face of the framing, in which bracket the end thrust was taken.

In the same period the self-acting feed motion through spur gears had been applied by a Mr. Lewis of Manchester to a wall drill. On the spindle above the lower bearing a spur pinion was keyed engaging with a wheel on a feed shaft parallel with the spindle, the driven wheel being engaged or disengaged by a sliding clutch. At the top of the feed shaft a spur pinion engaged with a wheel having its boss threaded to fit a square threaded screw cut on the upper part of the spindle, thus feeding the latter. Hand feed could be substituted for that of power by means of a handwheel on the feed spindle.

Boring Machines

The vertical lathe dates back to the early part of the nineteenth century. It was in use before Bodmer improved it, crystallizing it practically into its present form. The foundation or base carried the spindle on which the circular table

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or faceplate was keyed. The tool-box with down-feed motion was carried on a horizontal cross-slide with vertical adjustments on uprights flanking the table. The advantages claimed for it were precisely those claimed to-day.

There were many boring machines both vertical and horizontal in the forties to meet the requirements of the marine engine builders. There were big cylinders in those days, necessary because of the very low pressures adopted, and they were generally bored in vertical machines.

In one of Maudslay's early lathes may be traced the beginnings of the milling and boring machines. The headstock was

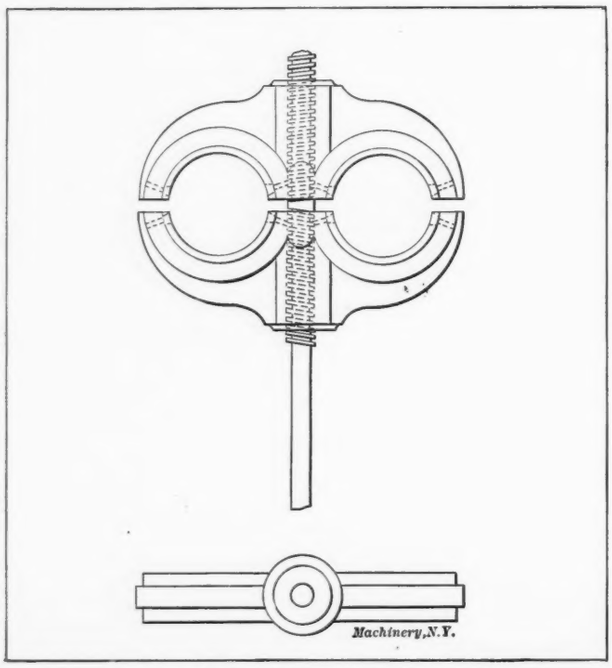

Fig. 20. Friction Collars of Screw Feed Wheel, Whitworth Drilling Machine

provided with a side or lateral traverse by hand or power on a rather long base which would qualify it for milling. Work to be bored was clamped on a table on a bed slide or carriage of large area, the table being raised or lowered on the slide by means of four screws.

A boring machine by Maudslay was already differentiated from the lathe used for boring. The table possessed transverse motion by a screw for boring holes in parallel. The boring bar was capable of vertical adjustment by that movement of its bearings in guides actuated by screws, both driven simultaneously through bevel wheels from a horizontal shaft at the top, just as the cross slide of a planing machine is elevated. The bar was rotated by a five-stepped pulley, grooved for gut band, thence through spur gear to the bar. A screw at the left provided for the horizontal feed of the bar. The feed was put on by power by means of cord-driven pulleys from the bar itself.

Horizontal and vertical boring bars were in existence at Soho. The first was 12 inches diameter, hollow, and having space enough to bore a length of 14 feet 4 inches, and diameter of 4 feet 6 inches. The traversing screw was hand-cut. It was worm-driven, the gear on the end of the bar being a mortise worm-wheel. Differential gears were fitted for feeding the boring head. This machine was made in the period when Murdoch was there, of coal gas fame. There were several boring bars dismantled a few years ago. As Murdoch died in 1839 they must have been built a good while prior to that.

A vertical boring bar 14 inches diameter was the one which bored the cylinders for the screw engines of the *Great Eastern*. This was worm-driven, the gears being below the floor and protected by a plate. The traversing or feed gear was carried on a beam above, built into the wall. These tools were built into the walls and floors as integral portions of the works, and were the precursors of modern tools. Among these ancient machines the dates of which are unrecorded, but which must lie about the period of Waterloo, were lathes, boring machines, wall planers, and others.

After the opening of the Liverpool and Manchester Railway in 1830 there came a great boom in machine tool making. Railways were being constructed all over England between 1830 and 1840, and locomotives and trucks could not be built fast enough. Anything that saved labor was in great demand. The makers of self-acting tools were full of orders. During this period very many great improvements were effected, and the machine tools assumed in several instances nearly their present forms.

Ocean steam navigation was also a potent cause of development, for the marine engines of that time were of massive proportions requiring big boring and planing tools.

Nasmyth Steam Hammer

To this cause the invention of the steam hammer was due. A wrought iron paddle shaft 30 inches diameter was required for the *Great Eastern*, and no firm in England or Scotland would undertake to forge it. Nasmyth was appealed to, and designed his hammer on the essential lines which have survived to the present, except that it fell by gravity only. This was in 1839. The crankshaft was never made, a screw being substituted, and the hammer was allowed to be shelved. In 1842 Nasmyth when on a visit to Creusot saw his hammer at work froging a crank, and learned that the idea had been taken away by a visitor to Patricroft. Then he patented it, and orders came in quickly. Fig. 21 illustrates the first hammer, from a model now in South Kensington Museum.

An offspring of the steam hammer was the steam pile driver, the first two of which were used for the construction of the Keyham Docks, an extension of the Devonport Royal Naval Docks. They were termed steam hammer pile drivers, and were a grand success. A four ton falling weight making eighty blows a minute drove in piles 18 inches square and 70 feet long in 4½ minutes. Previously the same work done by a hand machine had occupied 12 hours.

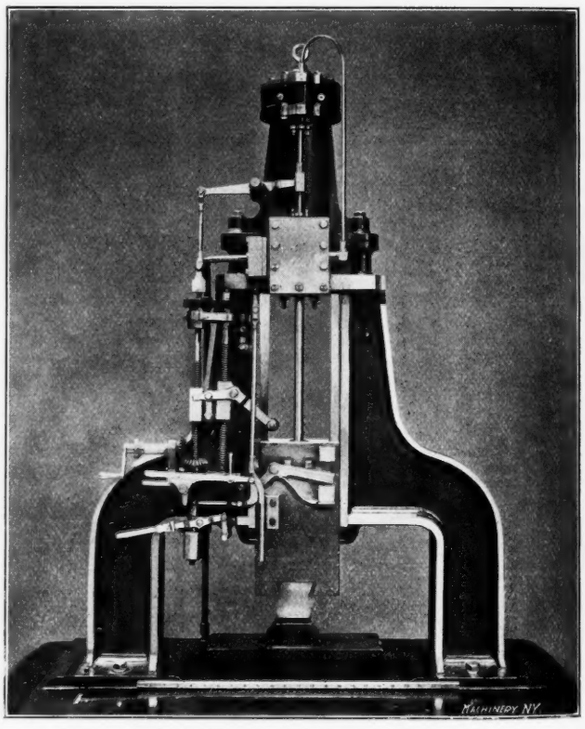

Fig. 21. Model of Nasmyth First Steam Hammer, in South Kensington Museum

When Maudslay began his labors there were no standard screws. Each bolt had its own nut, the two being marked to match. The subsequent work of Whitworth has somewhat eclipsed that of his old master, but he carried on and completed the labors which had engaged the attention of Maudslay from about 1800 to 1835, the time of his death.

Screw-cutting Machinery

One of Maudslay's early devices for originating screws, Fig. 22 (about 1800), and now preserved in South Kensington Mu-

seum, embodied an endless screw and tangent wheel as the essential element. The wheel was mounted with its axis vertical on a table to be slid along a lathe bed. Through a hole in the table frame the bar to be threaded was passed. A tool-holder was secured to the top of the disk, through which a concave chisel edge was projected downwards to come in contact with the bar to be threaded, being set by the tangent screw to the inclination of rake which corresponded with the pitch of the screw to be cut. A chasing tool for the same pitch was carried in a slide rest with screw adjustment, and

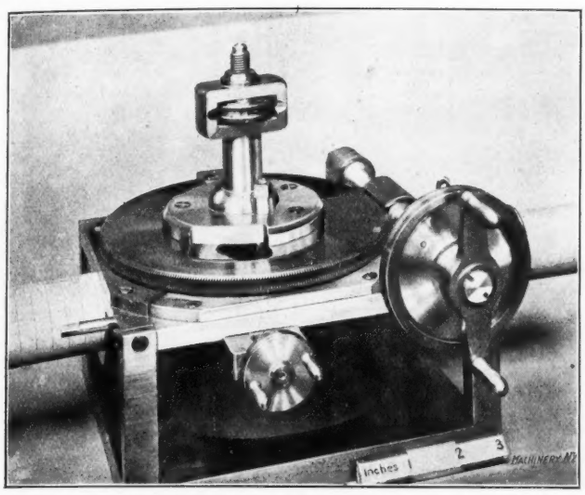

Fig. 22. Maudslay's Machine for Originating Screws (About 1800)

entered a hole at the side. On the bar being rotated, the chisel edge compelled the device to travel longitudinally, while the chaser following, cut the thread. The bar was of soft metal or of hard wood, and from this bar copies were made in steel. In the screw generating machine the essential was the setting of the generating instrument to the precise angle of a given screw. Everything depended on the accuracy of this setting. Maudslay produced a guide screw in the generating machine which he used afterwards in the screw-cutting lathe. In the latter he produced a screw 5 feet in length by 2 inches diameter with fifty threads to the inch. Its nut was 12 inches long with 600 threads.

The screwing machines for threading and tapping were made between 60 and 70 years ago in nearly the same designs as many are at present. They were of horizontal type with

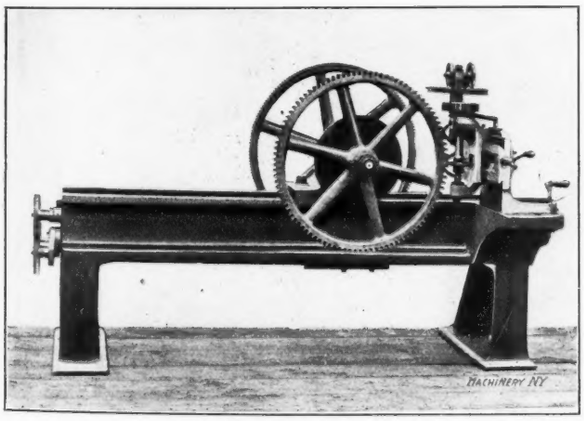

Fig. 23. Gear-cutting Machine, Joseph Whitworth & Co. (1868)

either one or two spindles revolving the bolts, and a cross bar carrying the dies. After cutting, the reversal of the spindles ran the nuts off. A dark fish oil was used for lubrication. Apart from the slowness of their operation they gave practically as good results as those of to-day.

There was a nut tapping machine in the Maudslay shops, and also a bolt screwing machine with a long lead screw in front of the bed having a buttress thread of coarse pitch, and a swing plate with change gears. The clasp nut was a half nut occupying the front portion of the screw, with which it was held in contact by a massive pear weight, much as the pawls of some hand cranes are now. On lifting this at the completion of a traverse, a suspended weight at the right-hand end of the bed pulled the carriage back ready for another cut.

Gear Cutters and Milling Machines

Maudslay made form bevel gear cutters of a peculiar kind, supported on flat topped lathe type of beds. The headstock, comprising two bearings and a mandrel, carried a dividing wheel at the rear end of the mandrel, and the wheel blank at the front end. On a small shaper arm standing out from the bed the tool holder was reciprocated by a crank motion. The inner end of the bar was pivoted on a point in the axis of the mandrel, while the other was fitted with a finger which was retained in contact with the form; a hollow templet larger than the tooth shape held in an adjustable bracket.

Fig. 23 illustrates a Whitworth spur gear cutting machine of date 1868, having a capacity up to 4 feet 6 inches. It is of a design that was very popular a few years ago. The dividing wheel is seen on the farther side of the bed. Its large diameter is noticeable. The cutter spindle is cord-driven, power being gained through spur gears. The change gears for pitching are seen at the left-hand end of the long bed, and the index handle for operating it at the right-hand end. The cutter slide has a self-acting feed across the tooth faces, and is arranged to swivel in the horizontal and vertical planes for dealing with bevel and worm gears.

A small cutter forming machine by Whitworth & Co., date 1868, is seen in Fig. 24. It is based on the principle of some gear cutters of the period, using a dividing head with circles of holes and an index peg. Its cutter spindle was cord-driven, the cord running over small guide pulleys, and the cutter

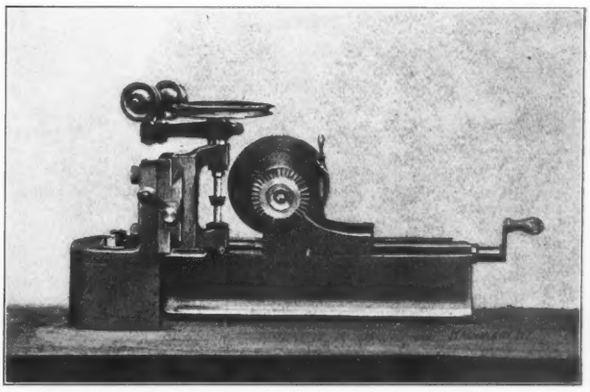

Fig. 24. Cutter Forming Machine, Joseph Whitworth & Co. (1868)

slide was traversed by hand. The cutter was mounted on the spindle of the dividing head, and the slide which carries the latter was adjustable along the bed by hand to suit cutters of different diameters. The cutter head is arranged to swivel in horizontal and vertical planes to suit angular and other cutters. Formed cutters are produced by hand profiling by means of the two handles shown.

The employment of rotary cutters in place of single-edged tools was an epoch the full development of which has been reserved for quite recent years. The first note of this was sounded more than a century ago when one Vaucasson, a Frenchman, invented the milling cutter. It was a very imperfect milling tool, with the teeth of much finer pitch than modern practice allows. The cutter was inefficient in its first form, and nothing but the lathe was available for its operation, and thus the single tools continued to hold their own until the demands made by governments for interchangeability in the parts of small arms brought the opportunity to the circular cutter. Eli Whitney was the man who first recognized, or at least actually developed, its capabilities, and he invented and developed the earlier type of machine for its operation.

There was a nut milling machine in Maudslay's shop in 1829, having been devised as an attachment to the lathe by Nasmyth, who had recently commenced working there. Maudslay wanted a model of a 200 H. P. marine engine made, and entrusted the work to Nasmyth. There were about 300 cast steel nuts to be made, and Nasmyth rigged up a dividing

plate and nut spindle on the slide rest of a lathe and shaped the faces with a milling cutter or "circular file" held in the headstock spindle. Subsequently a special machine was built for nut cutting for use in the factory, and when Nasmyth went into business for himself he built numbers of them for engineers.

Nuts were commonly shaped with a milling cutter in England more than 60 years ago. There was a machine by Archibald Milne of Glasgow in which an end mill shaped the faces. The nuts were mounted on a vertical mandrel projecting from a circular table, having 6 equidistant notches, locked with a spring catch and lever. A self-acting feed was provided for moving the nut up to the cutter. It was cord-driven from four-speed pulleys through a worm and wheel, pinion and rack on the under side of the table. The cutter spindle was driven slowly through spur gears from fast and loose belt pulleys.

A nut milling machine of 1866 by Whitworth is seen in Fig. 25. The nut mandrel was rotated by a worm gear and locked with a pin passing through holes in a division plate. The mandrel head was traversed along the bed past the cutter by a screw, and knocked out by a self-acting clutch arrangement. The cutter drive was by belt and worm gear enclosed. The nut mandrel is firmly held by a self-centering

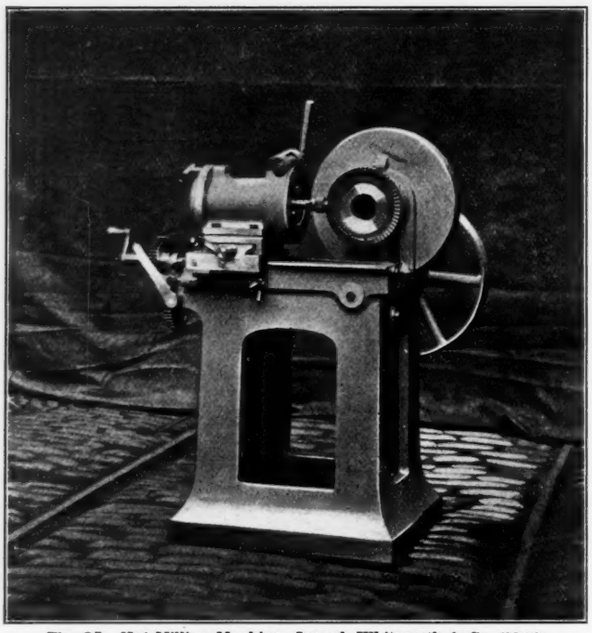

Fig. 25. Nut Milling Machine, Joseph Whitworth & Co. (1866)

three-jaw chuck, actuated by the worm and worm wheel. The chuck is formed with a sleeve which takes its bearing in the head and has keyed to it at the left-hand end a division plate. The chuck and nut mandrel are rotated by hand, and the position defined by a taper pin passing through holes in the division plate. The mandrel head is fed automatically along the bed past the cutter and tripped at any desired point. The cutter drive is by belt and spur gear enclosed.

Mr. Bodmer of Manchester had made a milling machine about 1824. But that was not strictly the first, which was one the late Mr. Parkhurst had seen, and was informed that it was at work in 1818 at a gun factory at Mill Hollow, Middletown, Conn. It was a hand machine. The cutter was driven by a belted headstock, with a three-stepped wooden cone removed from a lathe. The work was traversed under the cutter by a hand crank turning a pinion which slid a rack under the work table. If a second cut was required it was packed up. The idea was there but few improvements occurred until about 1850 when the Howe machine was introduced resembling in several respects the Lincoln miller designed by Mr. Pratt in 1854, in which for the first time a screw feed was substituted for that of the rack. The period of the American Civil War was prolific in milling machines used in the manufacture of small arms. All were of horizontal spindle design, and all were modeled essentially on the Lincoln type. The first universal machine was built about 1865 after the design of Joseph R. Brown, one of the founders of Brown & Sharpe Mfg. Co. The machine, Fig. 26, is still in existence in the works. Essentially it comprises the features of present-day machines, but the latter embody many features which add to their convenience and fulfill the requirements now demanded of a machine.

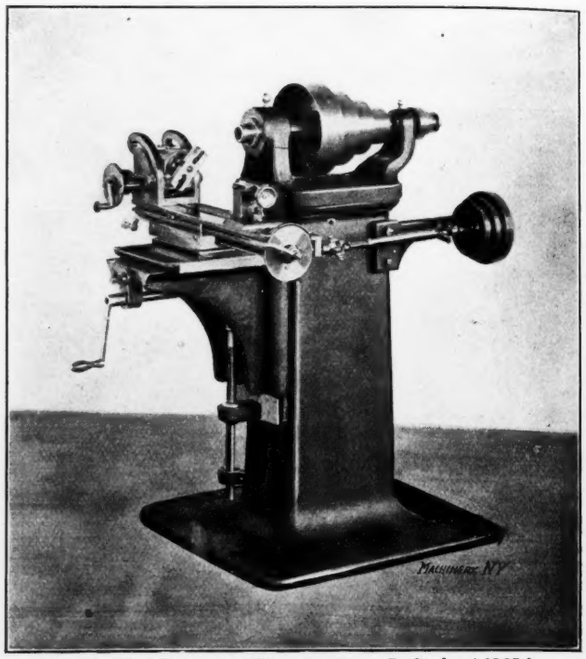

Fig. 26. First Universal Milling Machine. Built about 1865 by Joseph R. Brown, of Brown & Sharpe Mfg. Co.

Fig. 27 illustrates a very massive milling machine with inserted tooth cutters by Whitworth & Co. in 1867. It was designed for tooling the flat faces of marine cylinders and work of similar character. It was driven by a steam engine through worm gear. The work was attached to the table in front, which slides on a bed in front of the main upright, and is provided with cross adjustment by hand. The automatic feed of the table along the bed is operated from the

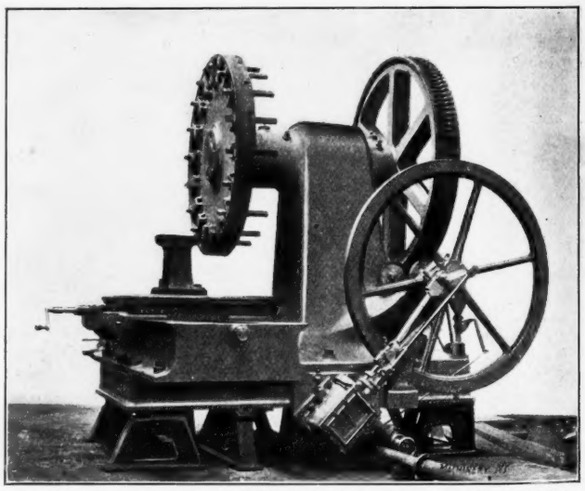

Fig. 27. Very Large Type of Milling Machine, driven by Steam Engine. Joseph Whitworth & Co. (About 1867)

worm shaft through change gears, and worm wheel on the screw, disconnected by hand-operated clutch at the left-hand end of the bed. The cutters are ordinary tools, each fixed by a clamp plate and two bolts, and may be placed with their cutting edges either on the edge or on the face of the disk as desired.

Nasmyth was the first to build the independent machine tool driven by its own small engine, abandoning the shafting, pulleys, belting, and laying down steam pipes instead. This arrangement has met with great favor in boiler making and plating shops where the machines are mostly heavy and scattered. Such machines are still made and used, though the electric motor drive is rapidly displacing them.

THE MAKING OF TOOL STEEL

ERIK OBERG*

Few mechanical processes have, during the general progress of engineering, undergone so little change as the methods and processes employed in the making of tool steel. With the exception of a more direct method for introducing the carbon into the steel, it may be said that, in general, the same methods are still used as were employed centuries ago. Improved methods for heating the furnaces and for handling and working the steel at various stages of the manufacture have, of course, been introduced but there has been no new principle applied in the actual production of the steel.

Before describing in detail the various processes and operations involved in the making of tool steel, the general procedure may be briefly reviewed as follows: Tool steel is made by using low phosphorus and sulphur wrought iron and adding carbon to it. Two methods have been in use, the older one being the so-called cementation process, in which the wrought-iron bars are packed in air-tight retorts with powdered charcoal placed between the bars. When the retorts are thus filled, they are put into a furnace, called the cementation furnace, where they are heated to a red heat and permitted to remain at that temperature for several days. During this time the iron will absorb carbon from the charcoal up to about 1½ per cent of its own weight. The process, in fact, is similar to the ordinary case-hardening process for giving parts made of low-carbon machine steel a hard high-carbon surface. The carbonized bars, called "blister" steel, are then cut up into small pieces and are re-melted in a crucible, and from that poured into molds. The billets thus formed are afterwards hammered or rolled into the desired shapes.

The newer method, largely employed at the present time, consists of putting small pieces of wrought iron directly into a crucible together with the proper amount of powdered charcoal. This charge is then melted and permitted to remain in the molten state for some time before being poured into molds. While in the molten state the iron will absorb the carbon much quicker than when only red hot, as in the cementation process. When the carbon is added directly in the crucible it is also possible to more accurately determine the carbon content of the final product and for this reason the newer method is far superior to the cementation process, which, however, is still considerably in use in the old steel manufacturing districts in Europe. The newer method is more commonly in use in America, and is the method employed in the steel-making plant of the Heller Brothers Co. of Newark, N. J. It is the object of the present article to briefly describe the making of tool steel as this process is carried on in the works of this firm.

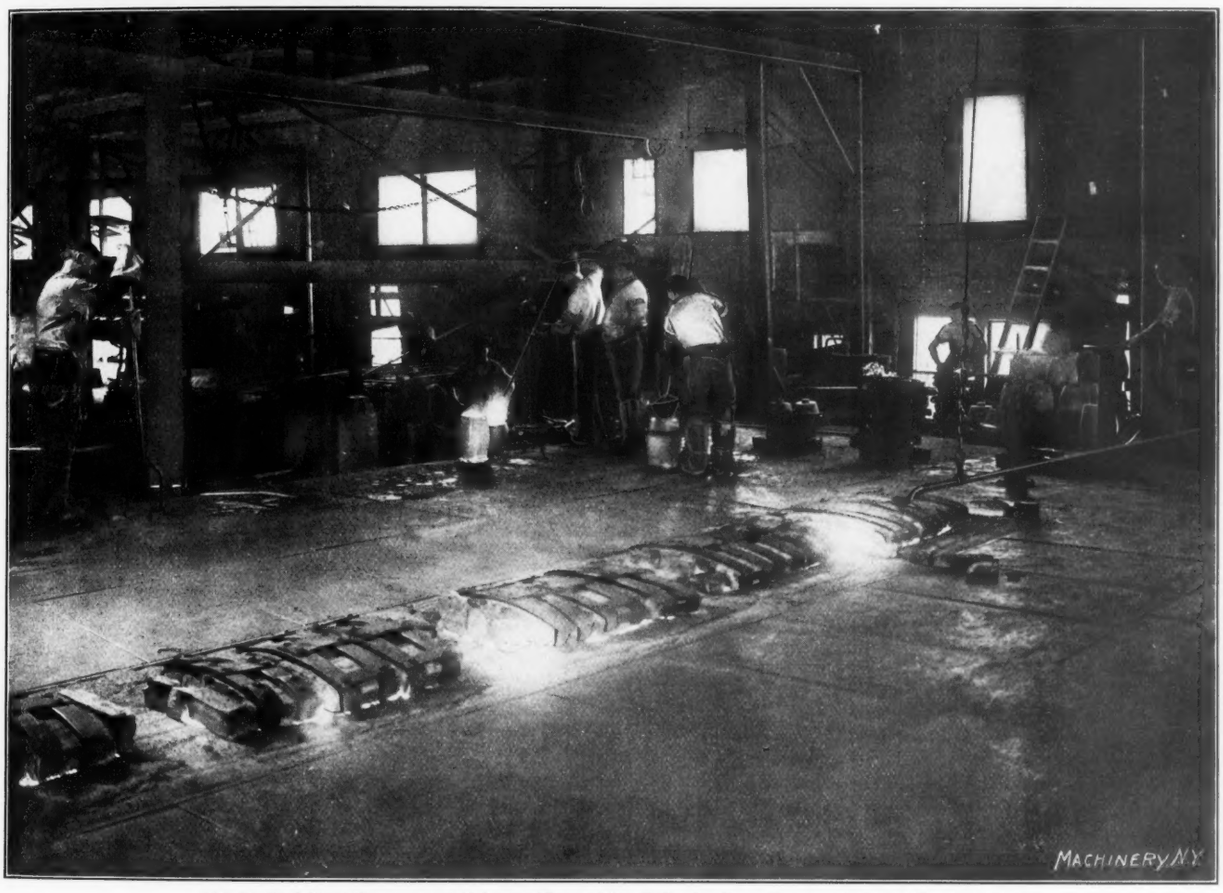

Fig. 1. Tool Steel Furnace and Charging Floor at the Heller Brothers Company's Plant, Newark, N. J.

History of the Heller Brothers Company

The original business of which the present plant of the Heller Brothers Co. is an outgrowth was established in 1836 by Mr. Elias Heller, the grandfather of the present officers in charge of the company's business. Mr. Heller at that time engaged in the making of files and horse rasps in a small shop in what is now the central part of Newark, N. J. Up to that time English files had been used exclusively in the United States and Mr. Heller was one of the first, if not the very first man, to make files in this country. The business gradually grew until the first buildings of the present factory were erected in 1873 at Forest Hill, a suburb of Newark, ten miles out of New York City on the Erie Railroad.

It was found that a relatively low-carbon steel of a uniform composition, such as is required in the manufacture of horse rasps was impossible to obtain at that time in the United States at a reasonable price, and, for this reason, in 1881, the firm built a small plant for the manufacture of high-grade tool steel primarily for its own use. Since then, however, this department of the plant has been considerably increased so that at the present time the firm manufactures a considerable quantity of steel for the market, specializing particularly in high-grade brands of carbon tool steel and high-speed alloy steels. The plant now includes a melting furnace having a capacity of thirty crucibles at a time, a number of steam hammers and a small rolling mill, besides the required heating and annealing furnaces. In 1899 the firm was incorporated under the name of Heller Brothers Company.

* Associate Editor of MACHINERY.

Material Used for Making Tool Steel

The raw material used by the Heller Brothers Co. for the making of tool steel is Swedish (Dannemora) wrought iron having a carbon content of from 0.10 to 0.20 per cent. This

Fig. 2. The Charge of Swedish Iron, Bag of Charcoal, and the Clay Crucible in which the Charge is melted

iron comes in flat bars, ½ by 2 inches, and is cut up into small pieces about one inch wide. The reason why Swedish iron is used in preference to other kinds is that it has proved itself superior in the making of high-grade tool steels. It is possible to obtain American iron having by chemical analysis practically the same composition as the Dannemora iron, and being as free from phosphorus, but nevertheless, when transformed into tool steel, the final product will not be of the same quality as that made from the Swedish iron. Metallurgists are at a loss to explain the reason for this. Steel makers say that the Swedish iron has more "body"; but, of course,

Fig. 3. Pouring the Molten Steel. The Photographic Plate shows the Intense Light and Heat and Fireworks Effect

this in itself does not mean anything except that it produces better results. One cause may be that the Swedish iron ore originally contains less impurities, and that for this reason wrought iron of a given quality can be produced without having passed through, in the same degree, the processes necessary for removing the impurities from the iron ore. These processes possibly change somewhat the crystalline structure of the iron, although its chemical composition remains exactly the same. This is mere theory, however, and should not be accepted as the demonstrated cause of the superiority of the Swedish wrought iron for the making of tool steel.

The Melting Furnace

The furnace in which the crucibles containing the metal are heated, which, as already mentioned, has a capacity of thirty crucibles at a time, is gas heated, the gas being obtained from a gas producer in the company's plant. The furnace is of the Siemens type, the gas entering it alternately from either side through checker plates. The action of the furnace is as follows: When the gas enters on one side, the exhaust gases pass out through the checker plates on the other side; these exhaust gases, being of a very high temperature, heat the checker plates rapidly to a red heat; at this time the entering gas is automatically shut off, and gas is admitted from the opposite side. This gas, then, passing through the heated checker plates, is thoroughly preheated, and when combustion takes place a much higher degree of total heat is obtained. The combustion gases from this side now heat the checker plates on the other side, and the process of pre-heating the gas as it enters alternately from the two sides of the furnace is thus automatically taken care of.

The charging floor, or the floor on which the men work who insert the crucibles in and remove them from the furnace, is level with the top of the furnace and iron-braced fire-brick covers, as shown in Fig. 1, are provided, which are kept over the openings of the furnace at all times except when a crucible is put in place or removed. The furnace, of course, is built up of fire brick, and is covered on top with steel plates. It is kept running continuously day and night, as it would

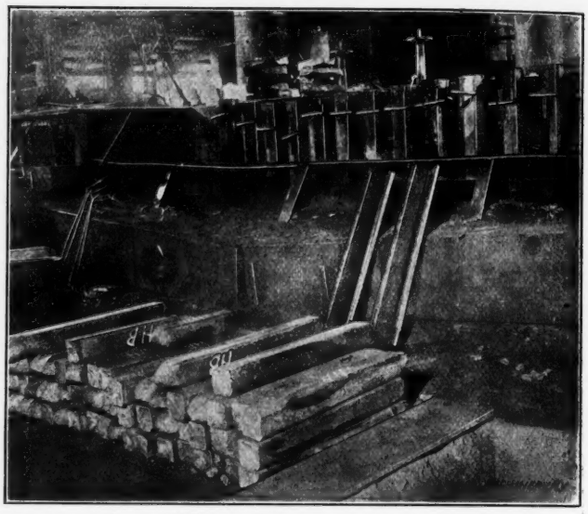

Fig. 4. A Row of Molds ready for the Metal to be poured, an Open Mold, and a Pile of Ingots

crack and be destroyed by the severe internal stresses due to sudden cooling if the fire were permitted to go out. The life of the furnace is from six months to a year, after which time it must be rebuilt.

Crucibles

One of the crucibles used for the melting of the iron is shown in Fig. 2. The height of the crucible is about 20 inches and it is one foot in diameter at the central part.

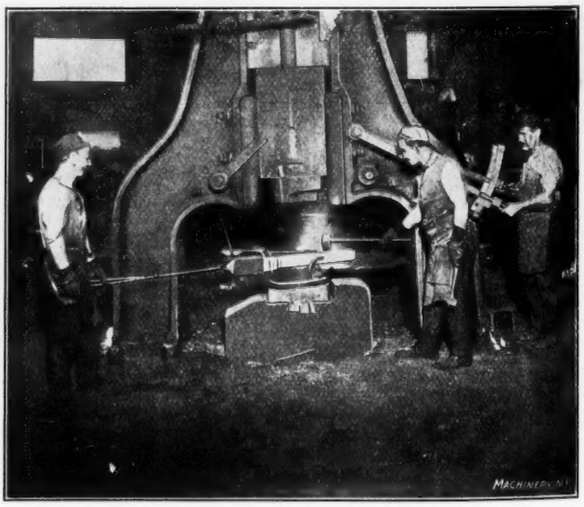

Fig. 5. First Stage in Hammering the Ingot to Size under a 2500-pound Bement Hammer

When placed in the furnace it is provided with a fire-clay cover not shown in the illustration. The crucible has a capacity of seventy-five to eighty pounds of iron. It is made from a mixture consisting of several foreign and domestic clays of

proper proportions. The crucibles are manufactured in the plant of the company, and are made in a manner similar to that used for making clay pots. A form is used to give the outside shape, and a revolving former is employed to shape the inside. When the crucible has been thus formed it is permitted to dry at ordinary room temperature, a storage room being provided where the crucibles are lined up on shelves for the purpose of drying. When properly dried, they

Fig. 6. A Collection of Tools used when handling the Ingots and hammering them to Size

are put into an annealing furnace where they are slowly heated to a high temperature. They must then be taken directly from the annealing furnace while hot, charged with the iron and charcoal, and put into the melting furnace. After this the clay crucible is not permitted to cool off until its usefulness is past. The heat of the crucible and the charge while in the furnace is from 2,500 to 2,800 degrees F.

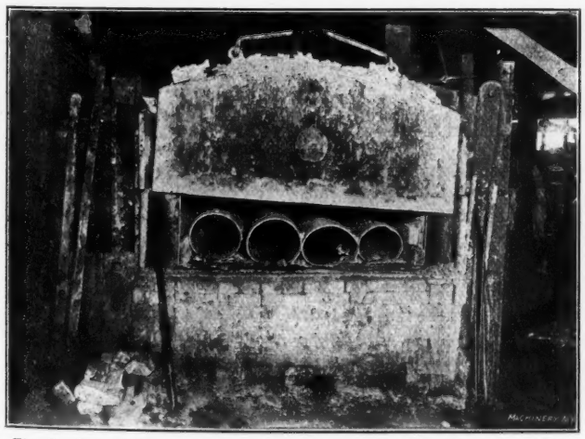

Fig. 8. One of the Annealing Furnaces, showing the Pipes into which the Tool-steel Bars are placed while being heated for annealing

Comparison between Clay and Graphite Crucibles

The use of clay crucibles in preference to crucibles of graphite is important in the making of high-grade tool steel, and is in accordance with the practice employed by the best English steel makers at Sheffield, where the clay crucible has been used for this purpose for centuries past. When the clay crucible is used, there is absolutely no possibility of any extraneous matter mixing with the charge, and the carbon content can be very closely predetermined. When a graphite crucible is used, small particles of graphite will flake off from the inside of the crucible and these particles will mix with the charge. They will, however, not enter into chemical composition with the steel, but will merely mix with it mechanically, so that, in the steel, there will be small particles of graphite imbedded, thus producing small holes and flaws in

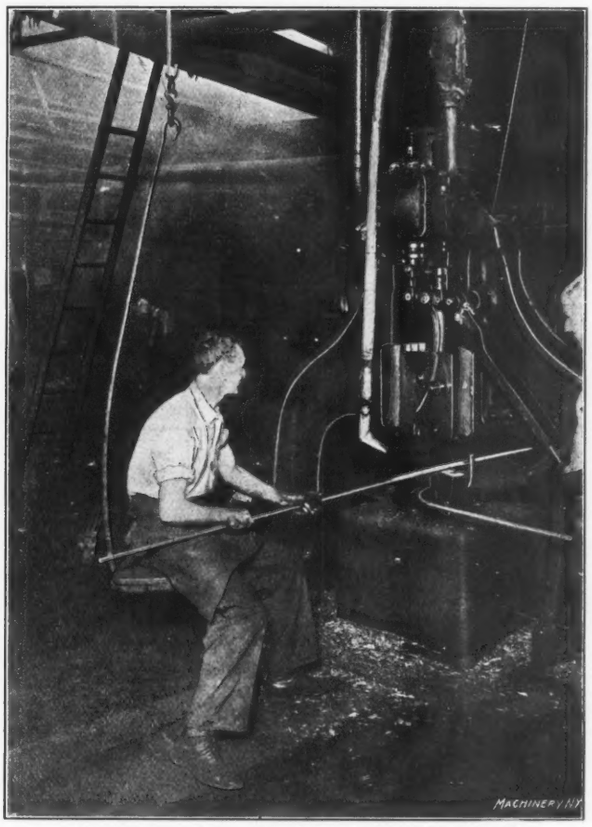

Fig. 7. Hammering a Round Bar to size under a Small Bement Hammer

the finished material. The graphite crucible, however, will last longer, and is therefore cheaper to use, but when a high-grade tool steel is to be produced the clay crucible is the only one which will give entirely satisfactory results.

Melting and Pouring the Steel

The work of charging or filling the crucibles and pouring the molten metal into the molds is carried out on the charging floor, shown in Fig. 1. The crucibles are charged with about seventy-five pounds of wrought iron cut up into pieces, as has already been mentioned, a pile of wrought iron ready for the crucible being shown in Fig. 2. About half of the iron is first put into the crucible, then a bag containing the powdered hardwood charcoal, shown on the top of the pile of iron pieces in Fig. 2, is put in, and finally the remainder of

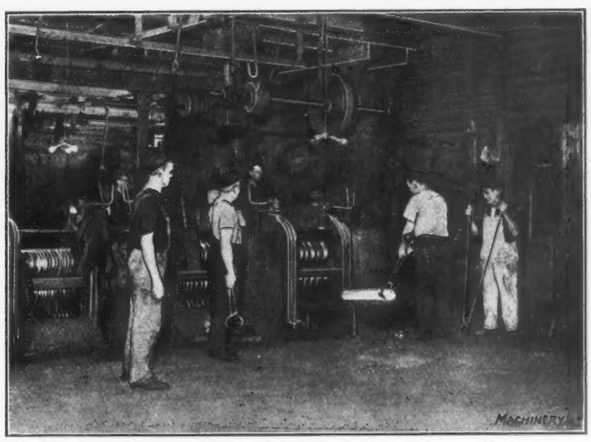

Fig. 9. The Rolling Mill, showing the Ingot just before it passes between the First Set of Rolls

the iron charge is placed on top of this. When high-speed steel is made, other ingredients, such as chromium, tungsten, molybdenum, etc., are placed in the crucible together with the charcoal and iron.

The carbon content in the tool steel is determined by the amount of charcoal in the charge; some carbon, of course, is contained in the wrought iron, so that it is not possible to calculate directly the proportions of charcoal necessary for a certain weight of iron to produce a given percentage. Some of the charcoal is also lost in the slag. The common method of determining the amount of charcoal required, however, is to consider that each ounce of charcoal will give about 0.07 per cent carbon to the steel, or, as the steel maker would express it, one ounce charcoal gives seven "points" carbon. This proportion is approximately correct for ordinary carbon contents, but when steel of a high carbon content is required it is necessary to add charcoal in a greater proportion, partly on account of the fact that the original amount of carbon in the wrought iron is then of relatively less importance, and partly because more of the carbon is lost or wasted. The charge for high-speed steel of standard quality is proportioned so as to give 5 to 6 per cent chromium, 19 to 20 per cent tungsten, and 0.55 to 0.75 per cent carbon.

The crucibles are placed into and lifted up out of the furnace by means of large tongs, the men doing the work standing partly over the furnace while removing the crucible. In Fig. 1 a crucible had just been removed from the furnace from where it was immediately moved across the floor to the molds, which stand vertically, and into which the molten metal is poured to form the ingot. Before pouring, however, but after the crucible has been removed from the furnace, the slag collecting on the surface of the metal is first removed by a long iron bar, and then a small amount of manganese is put into the crucible. This prevents the oxidizing of the metal while being poured, and tends to insure freedom from blow holes or flaws in the ingots. A number of molds ready to have the metal poured into them are shown in Fig. 4, the photograph being taken from the level of the floor of the shop, which is several feet below the level of the charging floor. One of the molds which are made in halves, is shown opened up in this illustration. The molds are made of cast iron and the standard inside dimensions of the molds, and, of course, also the dimensions of the ingots, are four inches square, by about three feet long, the ingots containing about 150 pounds of iron, or the contents of two crucibles with a capacity of seventy-five pounds each. In Fig. 1, one crucible has just been poured into the mold and is now being recharged, while the other crucible stands on the side of the mold ready to be poured. Fig. 3 is a photograph taken at the moment of pouring the molten metal into the mold. The intense heat and the fire-works effect produced is well exhibited in the illustration.

As soon as the metal has been poured, the crucible, which is not permitted to cool off on account of the fact that in such a case it would be destroyed by cracking, is put back into the furnace to be heated up again before recharging. In some cases, when it has not cooled off too much during the pouring, it will be immediately re-charged without re-heating. When re-heated, however, it is removed from the furnace after a few minutes, and the charge put into it as already described. It is then immediately put back into the furnace where it is permitted to remain from four to six hours when it is again removed, and the metal poured, and the same process repeated. As the furnace is in operation day and night, about five heats are obtained in the course of twenty-four hours. A crucible will only last for about four to six heats.

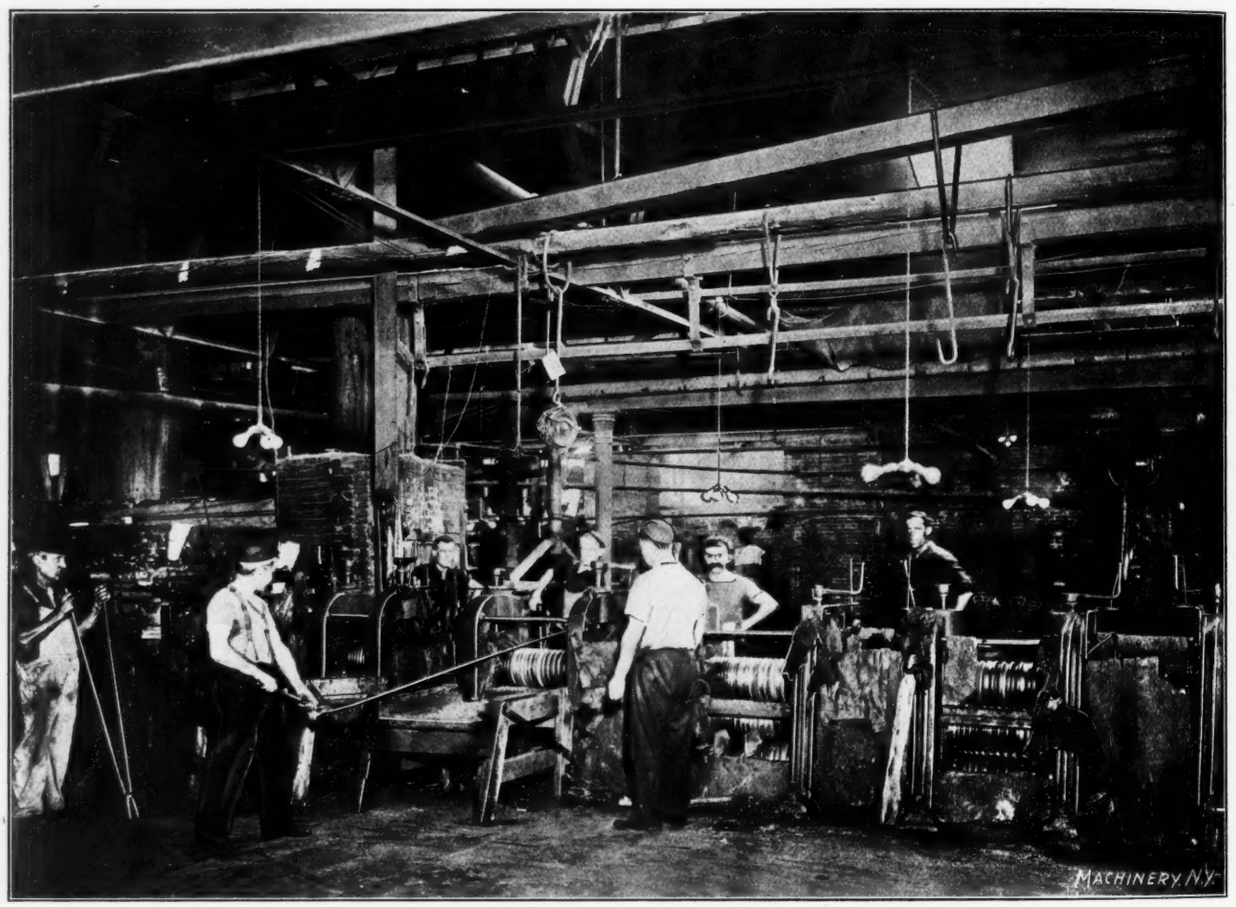

Fig. 10. The Rolling Mill, showing the Ingot after it has been rolled down into a Long Bar of Small Diameter

In order to prevent the steel from sticking to the molds, these latter are "smoked" by burning rosin underneath them which leaves a thick black coat of smoke or soot on the face of the mold. The ingots are permitted to cool off in the molds and are then removed and stored in piles on the floor, as shown in Fig. 4.

The Welding Process

The next operation performed is the heating of the ingots in a heating furnace to a welding or white heat, after which

they are put through what is termed the welding process. This consists in placing the white hot ingot under the steam hammer and lightly tapping it with gentle blows on the surface, so as to close up or weld all minute cracks or flaws that may be present on the outside of the ingot. This insures a homogeneous structure and freedom from flaws and cracks in the finished material.

Hammering to Size

After having been welded, the ingot is either again permitted to cool down and it is then re-heated to a red heat, or it may be immediately taken and placed under the steam hammer and hammered down to the required size. In Fig. 5 an ingot is shown where the hammering to size has just commenced. The hammering adds to the firmness and quality of the steel and insures homogeneity of the material. In order to insure the correct size being obtained, tools similar to those employed by regular blacksmiths are used as stops or gages. A square block provided with a long shank, called a peg, of which a number are shown among the tools in Fig. 6, is placed on the anvil of the hammer and acts as a stop. This block is of the required thickness of the bar. When the steam hammer has hammered down the bar to this size, it will strike this block and is thus prevented from making the bar undersize. Two thin or flat blocks are also shown in Fig. 6, these being used to give the right thickness to the smaller sizes of flat bar stock. After the bar has been thus hammered down to a given size by using the pegs as stops, it is gaged by sheet iron snap gages at various places, in order to ascertain if it has the correct size uniformly along its whole length.

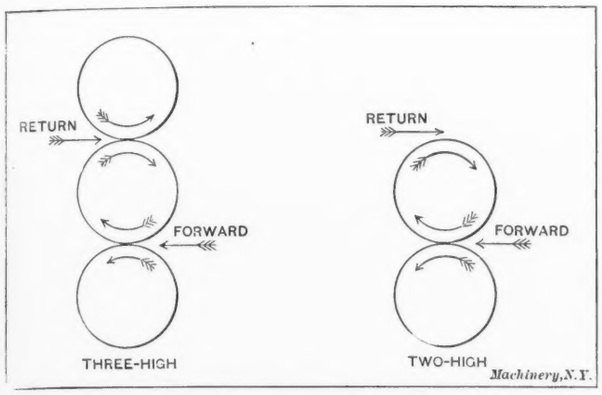

Fig. 11. A Diagrammatical Sketch showing the Difference between the Action of Two- and Three-high Rolling Mills

Round bars are made in a similar manner, swages similar to those used by the ordinary blacksmith being employed to obtain a round and smooth surface. In Fig. 7 is shown a smaller steam hammer under which the bars are hammered down to their exact dimensions, this being in a sense a continuation of the operation of hammering down the ingot, shown in Fig. 5.

When the bars have been thus hammered down to the correct size, it is necessary to anneal them in order that they may be soft enough for working. The bars are therefore placed in an annealing furnace. This furnace contains a number of long large pipes, the ends of some of which are shown in Fig. 8. They are regular cast iron water or gas pipes. The bars are placed in these pipes and the ends of the pipes are carefully sealed with fire clay. After this the front of the furnace is closed by the door or cover shown in the illustration, and the furnace is heated for about twenty-four hours; then the fire is deadened and the bars are permitted to slowly cool down for about two days. When the bars are taken out of the annealing furnace they are ready for shipment.

The Rolling Mill

All the ingots, however, are not hammered into shape; smaller sizes of square and round stock are rolled to the required size. Two illustrations of the rolling mill are given in Figs. 9 and 10. The ingot is first heated to a high heat and is then placed between the first set of rolls illustrated in Fig. 9, where the ingot is shown ready to pass for the first time between the rolls. It is here passed between the rolls from one side to the other, becoming smaller in cross section and of greater length at each successive pass. It is of interest to note how the mechanical operation of rolling keeps the heat in the bar, so that a great number of "passes" can be made without losing any of the original heat; as a matter of fact, the bar shows even a higher degree of heat at successive stages, the work performed on the iron in the rolling process being partly transformed into heat.

In Fig. 10 the ingot is shown rolled down into a long bar of small size. This illustration also shows to the left the heating furnace, and the general arrangement of the rolls and the rolling mill. When the ingots are to be rolled down to very small sizes it is necessary to divide the rolling operation into two stages, owing to the great length of the bar when it has been rolled down to a comparatively small size. In such cases the bar, after having first been rolled down to a certain size, is cut up under shears into shorter pieces of equal length, immediately after coming from the rolls. These pieces are re-heated in the furnace and are again passed between the rolls to produce the smaller sizes.

The rolling mill shown in Figs. 9 and 10 is what is called "three-high," that is, it consists of three rolls over each other, of which the bottom and top rolls run in the same direction, while the middle or center roll runs in a direction opposite to both. From the diagrammatical sketch, Fig. 11, it will be seen that by this arrangement it is possible to pass the bar first through the two lower rolls over to one side and then back again through the two upper rolls to the first side. In this way the bar is reduced in size a certain amount each time it passes back and forth. When rolling mills are provided with one set of two rolls only ("two-high") and are not made reversing, as is the case with the set of rolls shown in use in Fig. 10, it is evident that it is possible to pass the bar between the rolls only in one direction, and the bar must be passed back over the top roll to the front side "idle," as is plainly shown in the engraving. When the bar has been rolled down to the required size it is annealed in the same manner as described for the hammered bars, and is then ready for shipment.

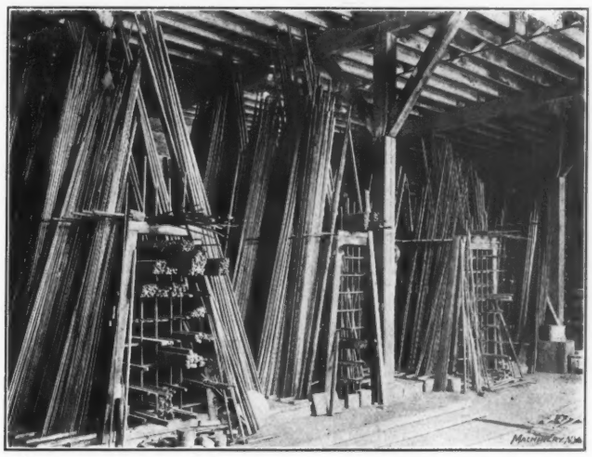

Fig. 12. A Corner of the Stock Room

In Fig. 12 is shown an illustration of a part of the stockroom, showing the finished bars in the racks.

* * *

The freedom from corrosion of tantalum, says the *Scientific American*, has suggested the employment of this metal as a material for writing pens, but tantalum pens have failed to pass a test for durability that is applied in France to steel pens. This test consists in loading the pen with a weight of 180 grammes (6 1/3 ounces) and moving a band of paper beneath and in contact with the pen at the ordinary speed of writing until 10 kilometers (6¼ miles) of paper have passed. The loss in weight of the pen should not exceed 0.7 milligram (0.0108 grain). The tantalum pens were found to lose more than twice this amount, but the loss has been reduced to 0.8 milligram (0.0123 grain) by slightly oxidizing the tantalum.

POWER TESTS OF A STOCKBRIDGE SHAPER

H. P. FAIRFIELD*

The following tests were made on an 18-inch shaper built by the Stockbridge Machine Co., Worcester, Mass., to obtain data relative to the size motor best adapted for driving the machine under normal conditions of roughing cast-iron. No attempt was made to learn what it was possible to accomplish by heavy feeding or abnormal depths of cut, but simply to go somewhat beyond the common shop usage in cuts and feeds. The few data shown in Table IV, for example, were taken merely as a check on those shown in the previous tables, as it was considered improbable that a shaper of this size would ever be used for roughing a cut so deep as one-half inch. I may say, at this point, that each table represents the average results of a series of runs made to conform as closely as possible to uniform conditions, and were made after the machine had been tuned up by careful observation and attention to adjustments, lubrication, etc., and with the cutting tool ground to a gage and kept sharpened to the original gage throughout the runs. A high-speed steel cutting tool was used on account of retaining its keenness for a longer interval of time than a carbon tool would do. The cutting speed selected (25 feet) for runs I to IV, inclusive, was decided on as that which would allow the use of either a carbon or high-speed steel cutting tool, and could be said to fairly represent average shop practice. The material cut was an average grade of cast iron such as is used in ordinary machine tool parts, and the block was cast into such a form as to preclude all springing of the work itself.

TABLE I

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/8	17	0.0147	25	1.20
1/8	17	0.0294	25	1.68
1/8	17	0.0441	25	2.14
1/8	17	0.0588	25	2.68
1/8	17	0.0735	25	3.49
1/8	17	0.0882	25	4.02

TABLE II

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/4	17	0.0147	25	1.73
1/4	17	0.0294	25	2.68
1/4	17	0.0441	25	3.22
1/4	17	0.0588	25	3.90
1/4	17	0 0735	25	4.40

TABLE III

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	17	0.0147	25	2.55
3/8	17	0.0294	25	4.29
3/8	17	0.0441	25	6.00
3/8	17	0.0588	25	7.67

Tables I to IV give the average of repeated runs where all conditions of length of cut, depth of cut, and cutting speed were made as uniform as possible for each series, the feed only being varied. The runs were made cutting the full stroke of the machine, a rather unusual condition; but, as it was desirable to know what, if any, additional power might be necessary, if full stroke was to be used, the tests were run as shown.

The additional runs tabulated in Tables V and VI were made to show the effect in power consumption of a change in cutting speed, also as a means of comparing the Stockbridge two-piece crank mechanisms with the ordinary type of crank-shaper. Table V is the average of a series of runs made with the machine in its normal condition as a two-piece crank-shaper, and Table VI is compiled from the same number of runs, but made with the mechanism blocked in such a manner as to convert the machine into an ordinary crank-shaper of the usual type. In making the tests V and VI, the length of the cut was shortened to 12 inches, which conforms very well to the average length of work likely to be done on a machine of this size.

While the cost of power consumed in the average machine shop is not a large percentage of the manufacturing cost, the up-to-date manager is giving this item consideration when he purchases machinery, and when a machine is shown to consume less power and at the same time is adapted to produce the maximum output, he considers it worth while. A glance at Tables V and VI shows that the two-piece crank is a considerable power saver as compared with the regular type of crank-shaper, and while the saving in an hour's time may not appeal to the casual reader, it most certainly will if he uses his pencil and considers the savings effected in a year's time.

These tables are also quite interesting as showing how speeding up in a shop increases the power consumed. While it is a common enough saying among machine users: "It takes power to do work," some cases that have come under the writer's notice lead him to conclude that not all machine men fully realize its full significance. At a recent exposition of manufacturers, a machine tool firm exhibited a line of machines designed to work the modern high-speed cutting tools to their limit. When asked by the exposition management what power it was likely to use, the company's figures were for less than one-half what it actually used. There was no restriction on the power and the company could have been supplied with ample power by merely asking for it, as it was only a question of the wiring and fusing which the management desired to settle. As it transpired, it was necessary for this firm to shut off all but a single machine, changing from one to the other as the show was on.

TABLE IV

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/2	17	0.0147	25	3.20
1/2	17	0.0294	25	5.43

TABLE V

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	12	0.0294	15	2.10
3/8	12	0.0294	17	2.68
3/8	12	0.0294	25	3.22
3/8	12	0.0294	30	4.02

TABLE VI

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	12	0.0294	15	3.08
3/8	12	0.0294	17	3.35
3/8	12	0.0294	25	3.62
3/8	12	0.0294.	30	4.16

In conclusion, the writer desires to again emphasize the fact that the tests were made primarily to establish the size or power of motor to be used as a driver on the above shaper.

* * *

In the report of the committee on fuel economies, at the American Railway Master Mechanics' Association convention at Atlantic City in June, W. C. Hayes, chairman, made the statement that the investigation of the committee has shown that less than three per cent of all the locomotives on all of the North American continent use anthracite, liquid and other than bituminous fuel. Hence, the problem of locomotive boiler design as regards fuel is mainly concerned with bituminous fuel.

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INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS

THE R. K. LE BLOND MACHINE TOOL CO.

ETHAN VIALL*

Many interesting things are to be seen in the machine tool building shops of Cincinnati; some possibly that are not new, others undoubtedly old but nevertheless of the nature of "shop kinks" to many mechanics who have not been fortunate enough to run across anything like them, and in the line of interesting tools and methods the R. K. LeBlond Machine Tool Co., certainly holds its own.

In Fig. 1 is shown the way nine grooves are milled at once, on the outside of the cylinders used on the LeBlond lathes to cover the quick change gears. These grooves are not very long, so the feeding is done by means of the large hand-wheel shown, which operates a worm and gear set into the head of the fixture.

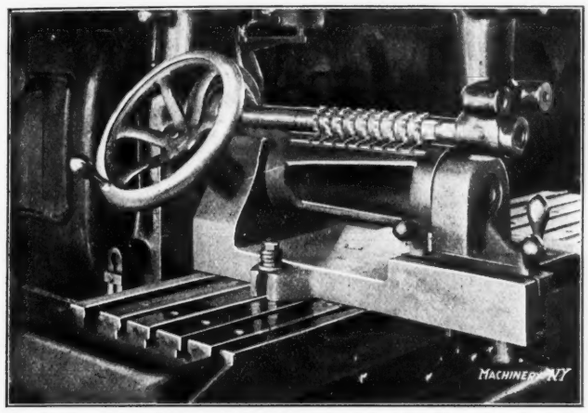

Fig. 1. Milling Nine Grooves simultaneously in a Quick-change Gear Cover

A jig for holding apron half-nuts while milling the dove-tail bevel is shown in Fig. 2. Two of the half-nuts are placed in the jig and the bevel on one side is milled; the jig-head is then indexed half a turn and the job finished. Four different sizes of half-nuts are milled in this jig, which accounts for the four grooves to be seen in the head on each side of the dove-tail.

The slots in the bottom of milling machine vises are milled while the vises are clamped onto a cast-iron block, Fig. 3, the base of which is so made as to be bolted to the milling machine table with the block either parallel or at right angles to the line of feed, so that slots may be milled at right angles to each other, with the same jig.

Short shafts are milled for Woodruff keys, while held in the upright V-vise shown in Fig. 4. This vise is also very

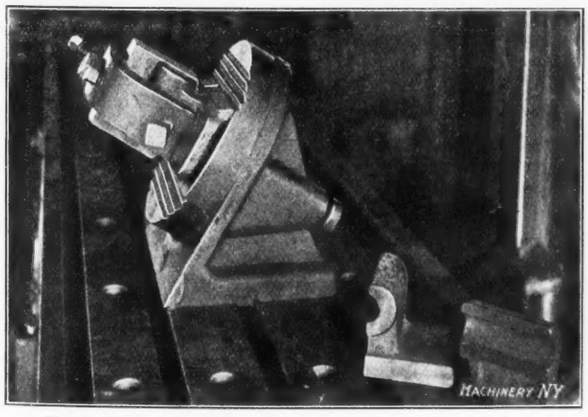

Fig. 2. Fixture for Milling Dove-tail Bevel on Apron Half-nuts

handy for many other jobs where it is necessary to hold round stock.

All sizes of plain cast-iron pulleys are faced and crowned in the special milling machine shown in Fig. 5, and a quicker or neater job could hardly be imagined, as with two mills working on opposite sides, simultaneously, only a half revolution of the pulley is necessary to finish the rim. By referring to the engraving, it will be seen that the pulley arbor and chuck, is driven from underneath by a worm and gear, and the big cutter heads are equipped with both cross and

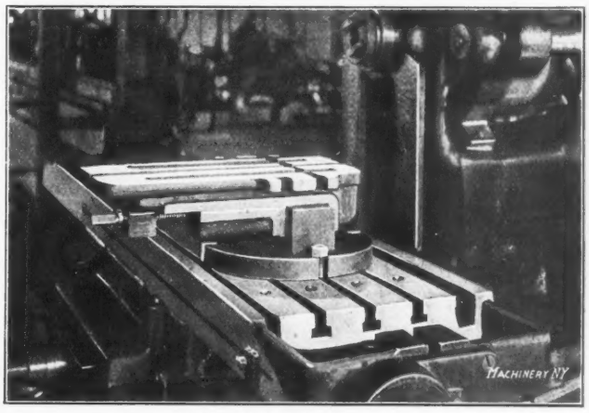

Fig. 3. Fixture for Holding Milling Machine Vises while slotting them

parallel hand feed, making it easy to set the machine for any size pulley within its capacity or to vary the amount of crown wanted on the face. The spindles carrying the milling cutters are back geared and the whole machine is made heavy and powerful in order to do good work.

A neat little jig used for holding the graduated sleeves used on the feed-screws of both lathes and milling machines, while drilling the set-screw hole, is shown in Fig. 6. In order to always have the set-screw hole in the same position relative to the numbers of the graduations, a little pointer for the zero mark on the sleeve is set into the face of the jig. Spacing collars are also used to bring the short sleeves properly under the drill bushing.

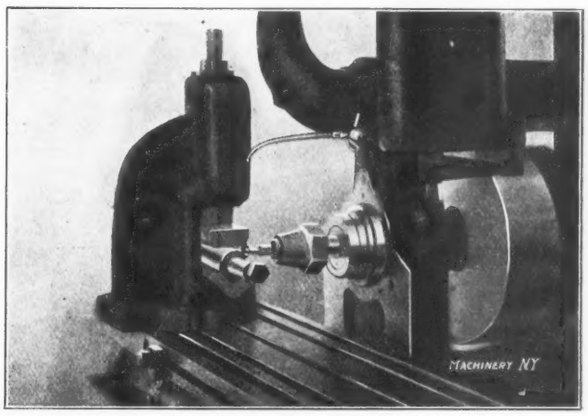

Fig. 4. Upright V-vise for Holding Shafts which are being milled for Woodruff Keys

At *A*, Fig. 7, is a special mandrel on which the large front box nut, for the No. 4 milling machine, is placed and turned after the threads have been cut in it. This mandrel is made to screw directly onto the lathe spindle, the square hole in the center being used for a wrench hold.

After the nut is screwed onto the mandrel, it is locked in place by a slight turn of the handled locking-collar *B*, which has a stop pin *C* set into the back and intended as a guide for setting the locking collar in the same position for each nut, by backing it up against the stop-screw *D*. The width of the nut is gaged by setting the point of the cutting tool against the hardened screw *E*. Another type of mandrel, known in most shops as a friction nose-chuck, is shown at *F* in this engraving. This mandrel screws onto the lathe spindle the same as the one just described, and it is used to hold large bored-out rings or collars, while turning the outside. A ring *G* is shown in place on the mandrel and the way it is locked by the pin *H* rolling and wedging in the beveled notch, is plainly apparent.

Fig. 8 illustrates a little tapping kink which is sometimes very useful when doing special work in the lathe. When

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tapping by this method, the tail-stock spindle is disconnected so as to be free to move out or in; the chuck holding the tap is connected to the lathe carriage by a short piece of rod as shown, the lathe is geared to cut the same thread as that on the tap and with the tap close to the work the feed is thrown in. If in backing out the tap, it is not desirable to use the feed on account of the backlash, the rod is easily backed out of the hole in the chuck, the key in the tail-stock of course keeping the spindle from turning with the chuck and tap, when the lathe spindle motion is reversed. Leading the tap in in this way, is not always possible or desirable, but as was said before, it is sometimes an exceedingly useful kink.

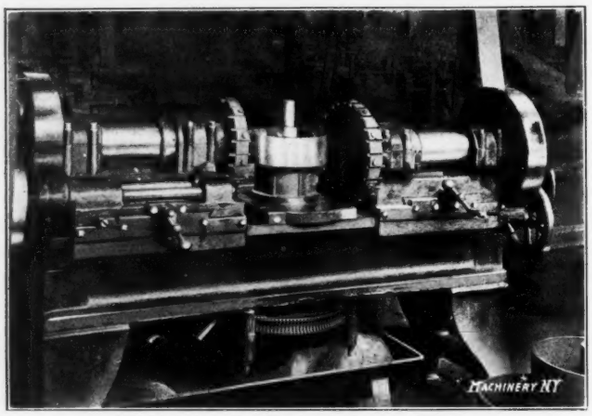

Fig. 5. Pulley Turning and Crowning Machine

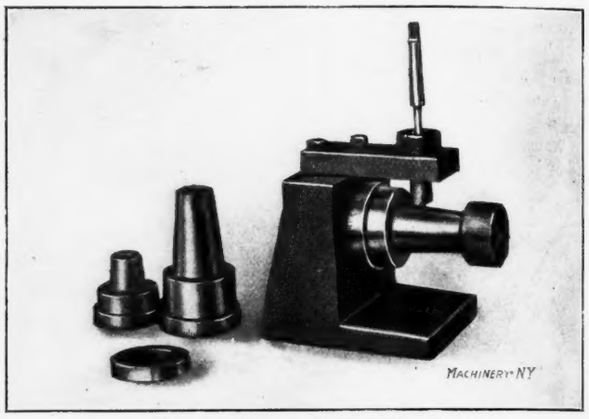

Fig. 6. Drilling Jig for Dial Sleeves

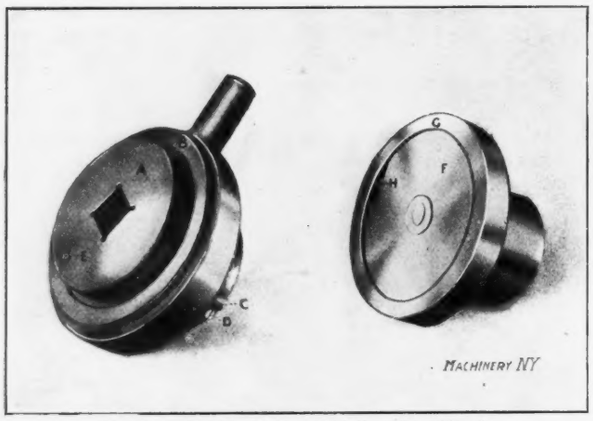

Fig. 7. A Nut Mandrel and Friction Nose Chuck

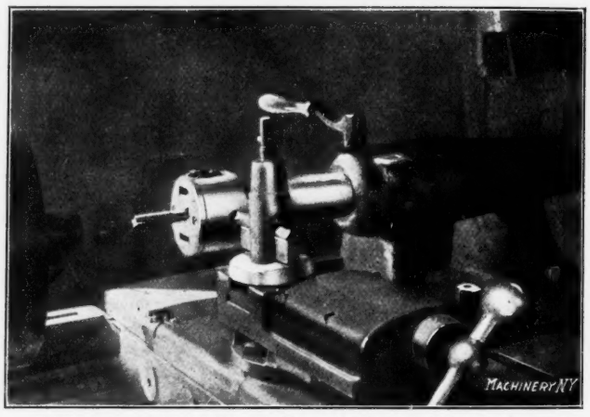

Fig. 8. Lathe arranged for Tapping with the Aid of the Lead-screw

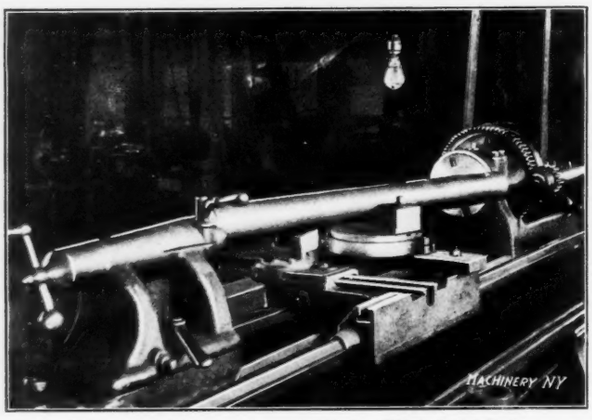

Fig. 9. Turntable for Reversing Heavy Work in the Lathe

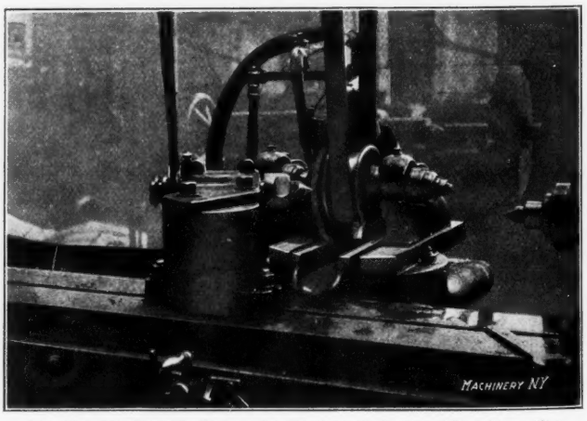

Fig. 10. Grinding the Point of a Foot-stock Center—First Operation

Where heavy work has to be turned end for end in a lathe, a turntable similar to the one shown in Fig. 9 is sometimes used. This kind of turntable is quite common in railroad shops, but it is seldom seen in other shops, even where it could be used to advantage.

The method of grinding the hardened foot-stock centers may be of interest, as it is done differently in some shops. Here the center is held as in Fig. 10, and the point ground; then using a male and female center, as in Fig. 11, the body is finished. Many shops leave a center hole on each end, that on the pointed end being all but cut off; the center is then hardened on this end, which often distorts the end which has been left on for the center hole. Next the piece is placed between centers and the body ground, and finally the center is placed in a split chuck and pointed.

Fig. 12 shows a magnetic chuck which was made by the foreman of the grinding room for special work.

In Figs. 13 and 14 are shown two views of a box jig for holding lathe aprons while machining the holes, and in Fig. 16 is shown the complete set of tools used. By closely examining these engravings, several interesting things may be noted. In the first place, all tools are driven from the drill-press spindle by the universal-jointed shank and socket shown. Then it will be seen that each tool whether drill, cutter or reamer, has its individual bushing which is kept from turning in the permanent jig-bushing, by a pin set in below the shoulder which fits into a notch in the latter; then, too, the long boring-bars *B*, *C*, *D* and *E*, have keyways running the full length of the pilots for the purpose of engaging keys set into the pilot guide bushings in the jig. These bushings are flanged, and set into another bushing in the jig, in such

a way as to be free to revolve with the boring-bar, instead of having the pilot revolve in it which prevents chips or dirt getting in and scoring the pilot, as usual. The flanges on the inner or guide-bushing keep all dirt from between it and the outer or bearing-bushing, and give long life to both bushings and boring-bars.

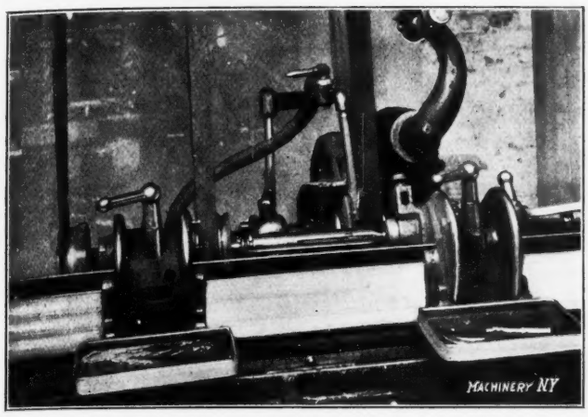

Fig. 11. Grinding the Body of a Foot-stock Center—Second Operation

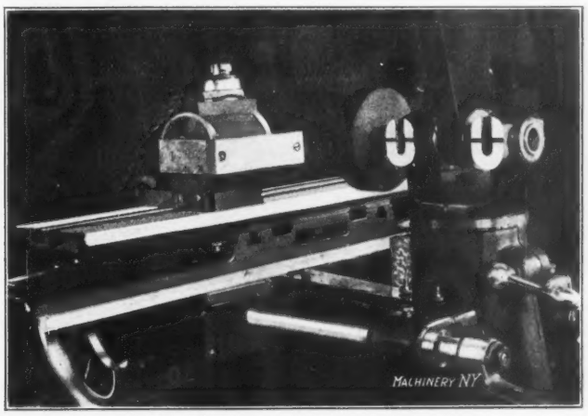

Fig. 12. Home-made Magnetic Chuck

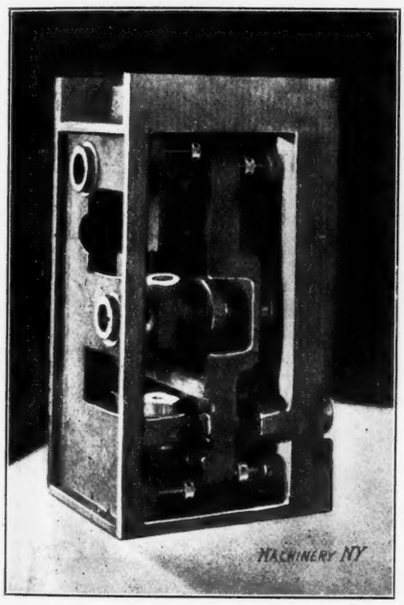

Fig. 13. Box Jig for Machining Lathe Aprons

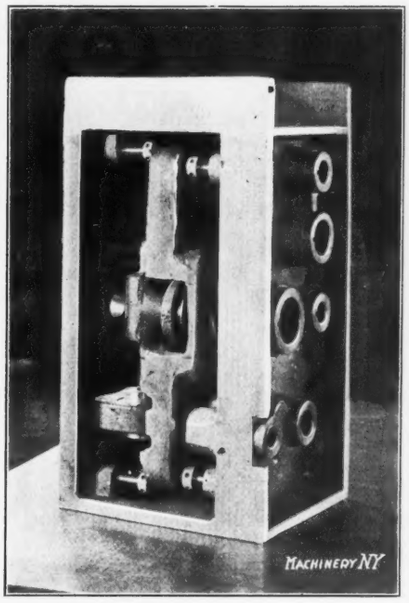

Fig. 14. Another View of the Lathe Apron Box Jig

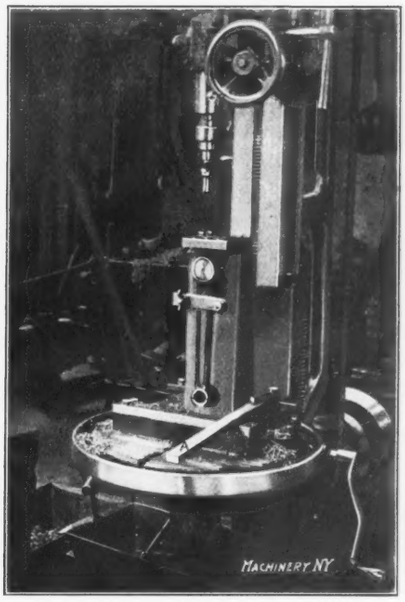

Fig. 15. Jig for Holding Connecting-rods

Fig 16. Tools used for Machining Lathe Aprons

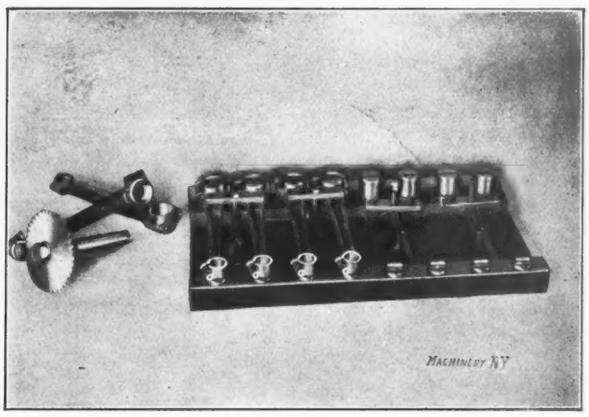

Fig. 17. Fixture in which Connecting-rod Bearings are cut off

During the recent dull season, in order to keep their regular force at work, a contract was taken for the machining of a large number of automobile engine parts, and two of the jigs used for some of the work on connecting-rods are worth describing. These rods and bearing-boxes are cast in one piece, and after the bearings are bored out, the work is put in a jig and the holes in the large end for the oil hole and cap screws, are drilled, counterbored, and tapped as shown in Fig. 15. This jig is made to slide back and forth, in order to bring the work in the proper position under the tool, by means of the hand lever *A*. This lever is made long so as to project through an opening in a sheet iron drum that is placed on the drill press table, around the jig, to keep the soap water that is used from spattering all over the shop.

After the holes are finished, the connecting-rods are placed eight at a time in the jig shown in Fig. 17, and the bearing-caps sawed off in a milling machine, using the saw shown.

In Fig. 18 is a front view of a small hand-operated graduating machine, with the part *A* of a compound rest in place, and the tool *B* just finishing a cut, and in Fig. 19 is a rear view, showing the way the machine is geared and operated. The indexing or dividing ratchet-wheel and dog is shown

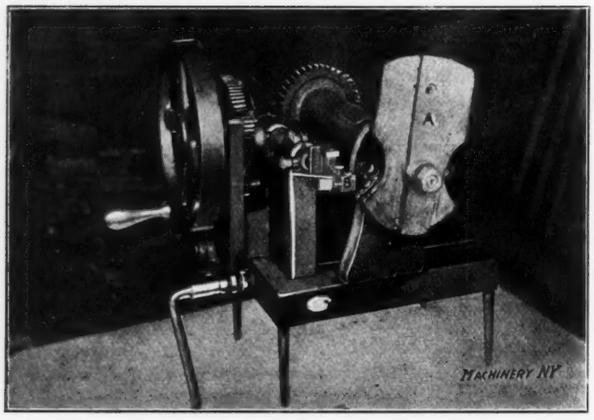

Fig. 18. Graduating Machine—Front View

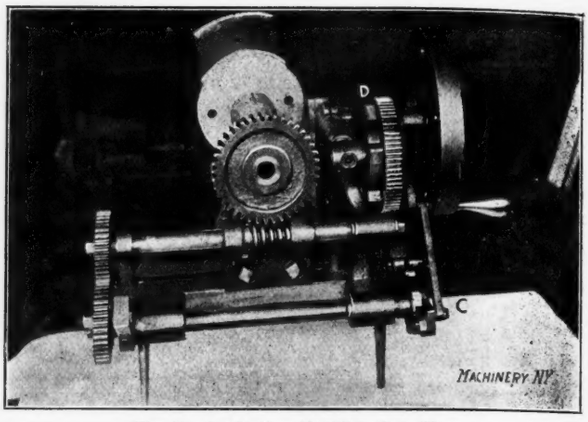

Fig. 19. Graduating Machine—Rear View

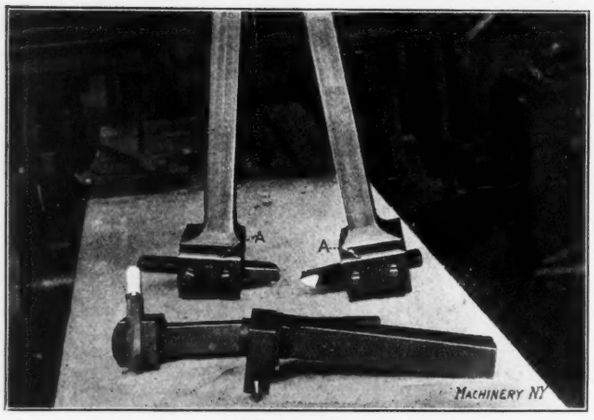

Fig. 20. Clapper-box Planer Tools for Side Facing

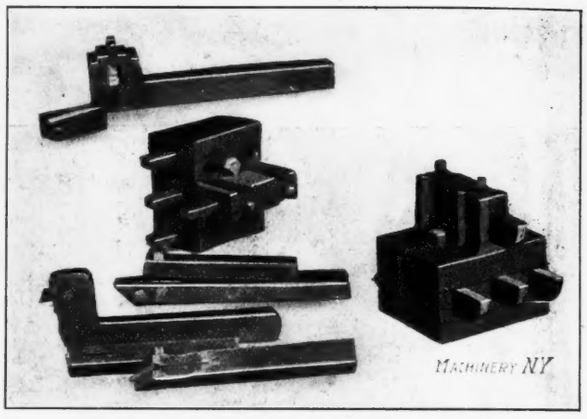

Fig. 21. Miscellaneous Inserted Cutter, Planer Tools

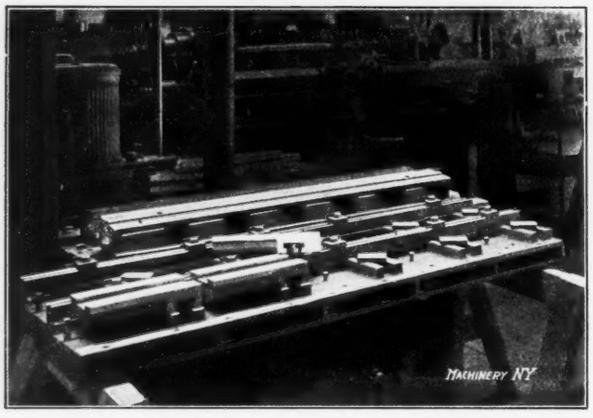

Fig. 22. Fixture for Holding Lathe Carriage Slides while planing them

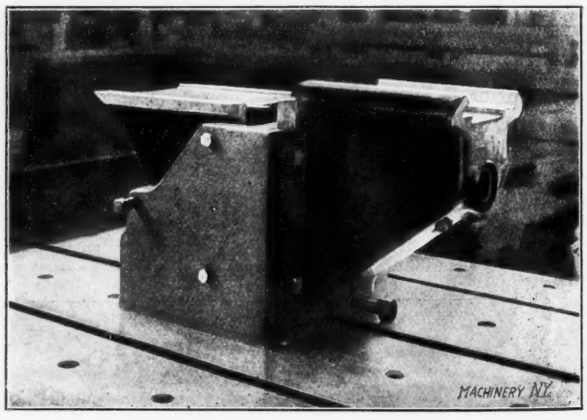

Fig. 23. Combination Fixture for Holding Grinder Knees while planing Male and Female Dove-tail Slides

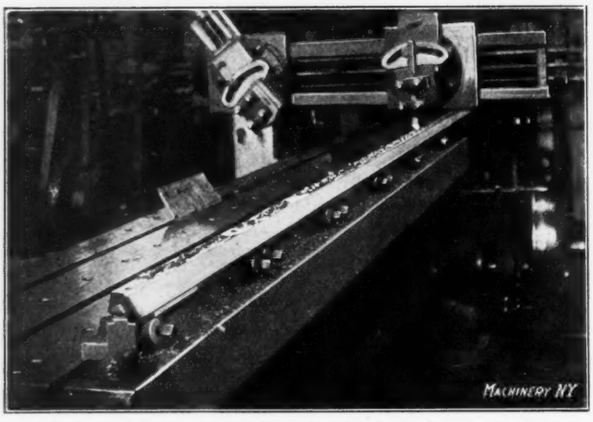

Fig. 24. Simple Form of Fixture for Holding Gibs on the Planer

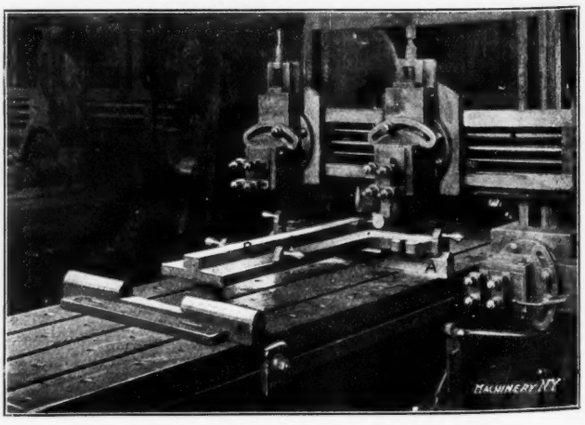

Fig. 25. Gage for Setting False V's for Lathe Carriages

at *C*, and a cam-wheel with four even and one high rise at *D*. This cam-wheel gives the tool its four short strokes and one long one, which is the usual motion.

In the planing department, there are a number of "clapper-box" tools such as shown in Fig. 20, used for side cutting on the planer. The two large ones, made right and left, have a little plunger and spring with a crosspiece *A*, which may be turned lengthwise of the clapper to allow the tool to be drawn back out of the way if necessary, but it is turned crosswise when the tool is in use, in order to draw the clapper and tool back into position at the end of the reverse stroke. Several other forms of tool holders, which need no explanation, are shown in Fig. 21.

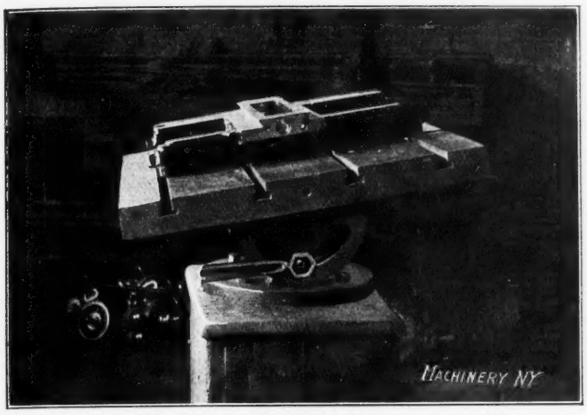

Fig. 26. Adjustable Table for Holding Lathe Carriages or Other Parts while Scraping and Fitting

A jig for holding ten top-slides for lathe compound rests, while planing the bottoms, is shown in Fig. 22, and in Fig. 23, is a combination-jig for holding grinder knees. The illustration shows two in position, but this is only done to show how they are held for the two planing operations, only one, of course, being planed at a time. Fig. 24 shows how gibs are planed, seven at a time, being held by pins inserted in holes drilled in the ends. Lathe carriages are lined up for the planing of the cross-ways, by being laid on the pieces *A* shown in Fig. 25. In order to get these pieces absolutely at right-angles to the travel of the planer table, the device *B* is used. This is simply laid on one of the pieces *A* as shown, and then tested by a dial indicator placed in the tool-holder. When the indicator reads the same for the entire length of *B*, the cross-piece *A* is tightened down, and the next one tested. A very handy iron table used to hold carriages or other parts while scraping and fitting is shown in Fig. 26.

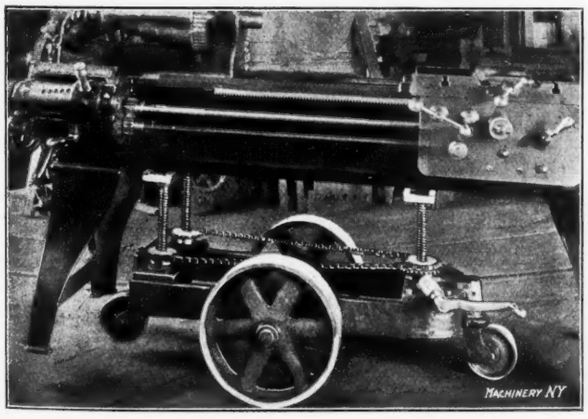

Fig. 27. An Elevating Truck for Raising and Moving Lathes

Every shop foreman knows what a nuisance the starting and stopping of an emery wheel is and how apt a man is to leave it running when he is through with it. The LeBlond shop had the usual trouble and so the arrangement shown in Fig. 28 was put on. As the man steps on platform *A*, the belt is shifted over and the wheel starts, and as soon as he steps off, the weight *B* pulls the belt over onto the loose pulley and stops the wheel.

Fig. 27 shows the ingenious truck used to move lathes around, the construction of which can be seen at a glance.

BIG GUN MAKING IN A NUT SHELL

This is how big guns are built at Elswick according to a clipping from *Pearson's Weekly*, a popular British journal, sent to us by a valued contributor. The account is graphic, but, though somewhat lacking in detail, it probably passes muster as the "real thing" with the class of readers to whom such "fluffy" literature appeals:

"Red hot steel ingots are forced into a rough cylindrical shape, either by the pounding of steam-hammers (some of them can give a blow of 700 tons), or by hydraulic presses. The largest of the latter gives a pressure of nearly 6,000 tons.

"Now that the rough forging has been made it has to be tested, and this is a critical part of the process: A few pieces are cut off from the main forging, heated in oil at a temperature of about 1,500 degrees F. and fixed firmly in iron jaws. Hydraulic pressure now tries to tear each lump in two, the strain sometimes rising to 46 tons on each square inch. If all the sample pieces stand the test, the forging is held good enough to make a gun. If not, another forging is made.

"If the test is satisfactory the rough pillar of steel is now 'rough-bored' inside and 'turned' on the outside. Then it is hardened by being dipped into a bath of hot oil; then bored and turned again till smooth; then annealed, or allowed to cool slowly from a high temperature; then it is 'fine bored' and 'fine-turned.' The next process is that of testing the surface. It is tested both chemically and by mirrors.

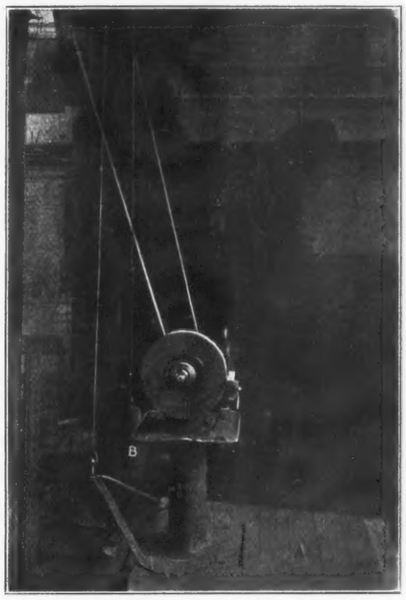

Fig. 28. Automatic Emery Wheel Belt-shifter

"The gun is now well into shape, but it needs strengthening. A deep pit is dug, and the gun set upright in it. Red-hot hoops of steel are dropped on from on top. As they cool they tighten. After each layer of hoops the gun is planed by a lathe to make it smooth for the next layer.

"Now the inside is rifled or grooved like a screw. When the powder chamber has been bored out and the breech-block fitted, the gun is nearly ready for its trials. The Elswick big guns are tested near Silloth, on the flat and lonely shores of the Solway Firth."

* * *

A remarkable high-speed run of regular passenger trains is being made by the Great Western Railway of England, in connection with transporting the passengers of the Cunard liners from Fishguard to London. The total distance from Fishguard to London is 261 miles, a distance which was covered, on August 30, in 268 minutes by the special mail train, and 276 minutes by a passenger train consisting of ten cars, and weighing 274 tons. The first part of the run is a difficult one, owing to heavy grades, including one, over a mile in length, of 1 in 50. The latter part of the run, however, presents more favorable conditions and the run from Carmarthen to London, a distance of 230 miles, was made in 228 minutes, including a stop of four minutes. At one section 75 miles were actually covered in 60 minutes, and 100 miles were covered in 83 minutes 49 seconds, a remarkable performance with so heavy a load behind the tender. The locomotive pulling the train was a four-cylinder, non-compound, six-wheel coupled engine weighing 75½ tons, cylinders 14¼ by 26 inches, working pressure 225 pounds, and with driving wheels 80½ inches in diameter.

AN ELECTRIC SURFACE GAGE

GEO. J. MURDOCK*

Geo. J. Murdock†

The purpose of the electric surface gage is to obtain aural as well as visual evidence of the truth of a plane surface. There are places on many classes of work, such as jigs, where it is difficult to see whether or to what extent the surface is out of truth, with the common surface gage. This is notable where there is an overhanging projection so close to the surface plate that it is impossible to look under. In dark weather it is very trying on the eyes to see whether the fine point of the needle touches the work or to what extent it does not. The electric current will communicate an audible signal when the needle comes in contact with the work, when under the most favorable circumstances such contact cannot be seen with the eye. This surface gage can also be used for many purposes for which the usual type is comparatively useless; for instance in truing up work on the face-plate or in a chuck, concentric with the axis of the lathe spindle, or for ascertaining the truth of a shaft between centers in the lathe or an arbor in the same position. When the pointer makes contact with the work, the electric current will speak to the brain through the ear where the eye cannot see.

Fig. 1 shows a side elevation of this gage. Its general design is similar to that of the gages in common use. The

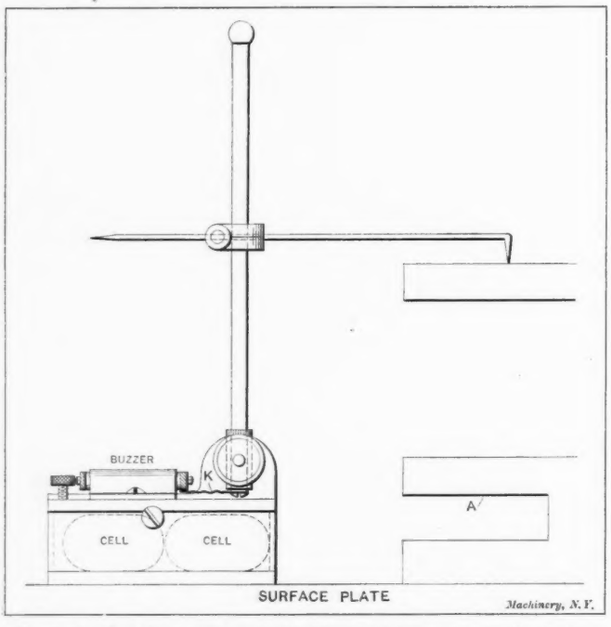

Fig. 1. Surface Gage equipped with Electrical Apparatus for Producing Sound when the Pointer is in Contact

base is cast with a recess in the bottom in which lie on their sides, two small dry cell batteries known as "Ever Ready" No. 650. This cell is 1¼ x ⅝ x 2 inches, and is especially adapted for this work. The ends of the cells are shown in Fig. 1 by dotted lines. On the top of the base is a small buzzer known as a midget, which is noisy enough for the purpose and which occupies but a small space. The positive and negative terminals of the cells are soldered together as shown in Fig. 3. The cells are then inserted in the base so that only the terminal *G* of the battery comes in contact with the metal of which the base is composed. The other terminal is passed up through a hard rubber bushing *H* (Fig. 4), and connected by a wire *J* to one binding post of the buzzer. The other binding post is connected to the insulated needle-bar by the wire *K* which is rolled up on a small wire so as to give it a coil. After it is coiled it is well to dip it in shellac varnish so that the current cannot short circuit through an accidental contact by the wire with the top of the base. It will now be seen that the circuit has two terminals, one being the base, and the other the needle point; consequently, whenever the point of the needle comes into contact with the work being tested, the current will pass through the work to the surface plate, and thence back through the base of the gage to the terminal *G* of the battery which is in contact with the inside of the base. Whenever the current passes through this circuit it energizes the magnets in the buzzer and causes it to

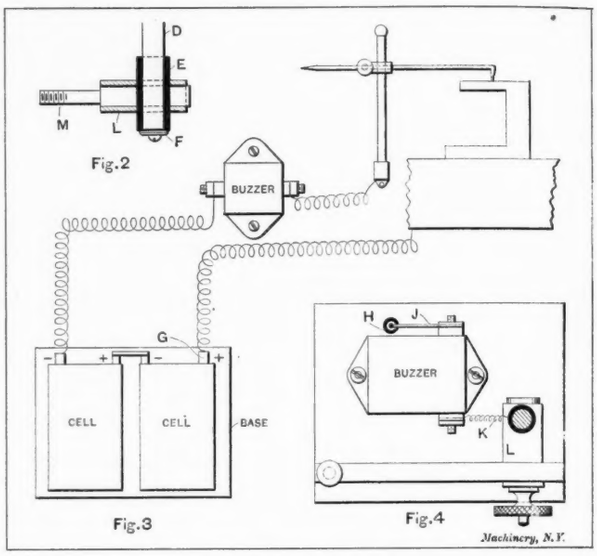

Fig. 2. Diagram showing Electrical Connections and Plan of Gage

give out a clear sound that can be heard several feet away. The moment the needle point passes to a low point on the surface of the work, the contact is electrically broken and the buzzer ceases to sound. At *E*, Fig. 2, is shown the hard rubber sleeve that insulates the needle-bar *D* from the base *L*. The usual form of binding device is used, of which the threaded stem *M* is a part. It is well to have a small shoulder on *E* so that the bar cannot slide down and make contact with the base of the tool, in which case it would run the battery down. It will be seen that no switch is required, as the circuit can only be closed through the needle-bar and needle.

The buzzer is secured to the top of the base by two screws, one at each end, and it does not require insulating from the base, as the binding posts are insulated at both terminals from the enclosing case. In trying the truth of a surface, as at *A* in Fig. 1, the foot of the work would be set up on parallels and the needle inverted with its point up; it can then be placed under this surface and indications taken in a location that would be difficult or perhaps impossible to see. For work in the lathe, the base of the gage can be set on the tool-post foot, and when the point of the gage strikes the work, no matter how lightly, the current will pass through the work in the chuck or on the face-plate to the lathe spindle, shears, and thence back through the tool-post foot and to the base of the gage, ringing the buzzer as the result, and the work can be trued accordingly. The same happens when an arbor is between the lathe centers, and no matter how fast it runs, the buzzer will sound when the point touches, when it is impossible for the eye to see it touch.

After the cells are inserted in the base, a metal bottom should be fitted so that they cannot drop out, and the work should be done so they cannot shake around in the base. It is also advisable not to leave the point of the needle long on the work as it runs the batteries down uselessly; but for all ordinary requirements they will last a very long time if a little care in this respect is taken.

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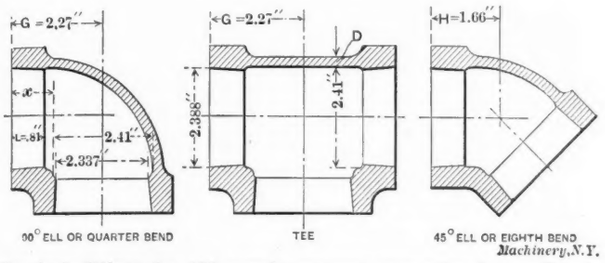
† George J. Murdock was born in New Berlin, New York, 1858, and received an academic and engineering education. He has been employed by the Hall Signal Co., New York; Western Instrument Co., Newark, N. J.; Manhattan Typewriter Co., Newark, N. J.; Sloan & Chase Mfg. Co., Newark, N. J., in the capacity of foreman, tool-maker, draftsman, foreman of instrument finishing work, etc. At present he is practicing engineering on his own account, making a specialty of instrument and precision tool work.

PIPE FITTINGS—THEORY VS. PRACTICE IN THEIR MANUFACTURE

F. W. BARROWS*

If I were asked what determines the thickness of ordinary, screwed pipe fittings, I should reply that the market price is now the final and controlling authority, all other essentials having long been dominated by this price; the weight being the conclusive test of merit. In theory the fitting should be strong enough to resist the internal pressure to which it may be subjected either by the fluid it is to convey or by the piper in "making up"; and the fittings now in the market have been proved, by numerous tests, to be not only strong enough to resist these internal strains, but have also successfully withstood the strains caused by changes of temperature, and by failure to "line up."

Using the formula $p = \frac{St}{r}$, in which p represents pressure; S, ultimate strength; t, thickness; and r, inner radius, and by substituting the values for ¾-inch gray iron fitting found in



Two-inch fittings for 100 pounds pressure, proportioned according to MACHINERY'S Data Sheet for June, 1905.
E (outside diameter of body) = 2.85 inches and tap diameter (outside at end) = 2.337 inches.
E − 2D = 2.41 inches or inside diameter of fitting, and $\frac{2.41 - 2.337}{2}$ = .0365 inch clearance for tap.
G − $\frac{2.41}{2}$ = 1.065 inch or X, and X − L = .255 inch, which is the clearance for the run of the machine or for making up. (Approximately three threads.)

Fig. 1. Sectional Views of Gray Iron Fittings illustrating Clearance for Threading and "Making Up"

the Data Sheet for June, 1905, giving dimensions for fittings to withstand 100 pounds pressure; p (bursting strain) = $\frac{20{,}000 \times 0.15}{0.55}$ = 5,454. This product divided by 100, the pressure for which such fittings are guaranteed, gives a safety factor of 54.54. Through stress of circumstances, a line of ¾-inch piping, connecting a testing pump with its work, which was to be tested to 1,000 pounds, was made up with ordinary (100-pound pressure) gray iron fittings and brass check valves; and so well did it stand this extreme (water) pressure, that it was continued in use for some years. The pump used was a lever hand pump and the efforts to keep the pressure above 1,000 for the time considered necessary for inspection, caused the gage to show at times as high as 1,500 pounds.

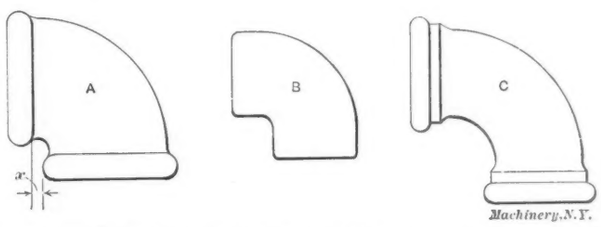
Taking t and r from the same list for 2-inch fitting, $p = \frac{20{,}000 \times 0.22}{1.205}$ = bursting strain of 3,734 (nearly), which would give, for this fitting, a safety factor of 37.34. This is without doubt a safe thickness.

Bronze (commonly called brass) fittings are usually made of yellow brass, which, strictly speaking, is not a bronze because it contains zinc, and for which the value of S may be safely taken (even for the miserable stuff used in "Rf" brass fittings) at 18,000; and t, as the patterns have an allowance for finishing, may be set down at 0.19. Substituting these values, the formula now reads: $p = \frac{18{,}000 \times 0.19}{1.205}$, which gives the bursting strain at 2,838, and a safety factor of 28.38 for this fitting, which factor, though less than that for the iron fitting, is still great enough for safety.

A line of six-inch piping, supplying steam from a boiler (gage pressure, 100) to an engine, ran along the ceiling and was connected, through a 90-degree elbow and a vertical pipe some eight feet long, to the engine. In the horizontal pipe there was an expansion joint of the ordinary, sliding type, and through somebody's oversight, this piping was used for several days without any stop for the expansion joint other than the rigidity of the elbow connecting the vertical to the horizontal piping. No accident occurred.

For 6-inch fitting, $p = \frac{20{,}000 \times 0.42}{3.41}$ = 2458, giving a factor of 24.58 for safety. With the same factor as for 2-inch, this fitting would have been 50 per cent thicker and the 12-inch, with the 2-inch factor, would be nearly twice as thick as shown on the Data Sheet referred to in the foregoing. For a 6-inch bronze fitting, if designed on the theory that a 2-inch fitting is a good standard to base calculations on, the thickness of body would have been from 50 to 100 per cent (as the value of S might be varied to suit different mixtures) more than "good practice" calls for. Some exception may be taken to the stated value of S for the brass fittings, but in my opinion it is placed quite high enough when taking into consideration the large amount of poor scrap that is commonly used, and the shiftless methods of melting and pouring allowed in some foundrys, through either inefficiency or carelessness.

To go back again to the common practice, a little further consideration of what might be called the necessary attributes of a good fitting, will show that the fixing of the weight has also fixed, within very small limits, the thickness; which term as applied to fittings, means the thickness of body between thread bosses. The weight should be properly distributed in the length, and in the diameter of the ends, which must successfully resist the strain of making up. The length



A—Beaded brass ell with long ends, with clearance for tool at "x" to machine beads, and large fillets between bead and body that fitting may be readily finished all over by strapping, as is often required.
B—Malleable iron ell without bands or beads, known as a gas fitting. Because of their uniform thickness these castings are more easily made sound—a very good feature of this fitting.
C—Gray iron longturn or water fitting. This fitting, because of its long, easy curves (a prominent feature in all its different forms), is well adapted for piping intended to convey liquids.

Fig. 2. Types of Common Fittings

must be such as to permit a suitable length of thread and also room for tapping without any danger of the taps striking together at the end of the run, or of the piper's being able to screw the pipes in until they meet. The threaded ends and the tapped holes vary in size, and the piper is usually a strenuous individual who may be relied upon to accomplish this if possible. Then there remains a certain amount of metal which may be divided between the length of end bands and thickness of body, the inner diameter of which, fixed by the pipe size, is usually made slightly larger than the outside of the pipe to prevent any shoulder being formed in tapping.

One may vary the diameter of the ends, but after having become acquainted with the aforesaid piper and his trusty "Stilson," the inclination will be to increase this diameter, even at the expense of body thickness. Again, when one has once learned how easy it is to crack a cast iron tee or ell through the "corners," there will be a still greater inclination to enlarge the ends of new fittings. The beaded fitting is probably the best form for resisting this making-up strain, and most brass fittings are made in this form, but the beaded, gray iron fitting does not seem to suit the trade.

If the foundry is to produce good sound castings, at the minimum cost, the change of thickness where the tapping boss and the band join the body, must not be too abrupt, a requirement which will keep the end size down and thus limit the amount of metal which can profitably be used in strengthening the ends. Another reason for not reducing the end size—for small fittings especially—is found in the practice followed

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by nearly all manufacturers, of tapping these smaller sizes with straight taps—thus bringing the strain of making up more exactly at the end of the fitting. Some makers claim that small fittings tapped in this way are just as good as the others. The smaller sizes of pipe show up rather badly; Briggs' standard gives a good length of thread, nicely tapered, which allows for quite a variation in size of the tapped hole, but requires, for a solid die, too much thickness of stock; at least this seems to be the verdict of those who make solid dies, as they are, almost without exception, made too thin. (Can this be another question of cost?) The dies are also often made with greater taper than Briggs' standard in order that the thin die may cover as much variation in size as the standard does, and even if the fittings were tapped taper, the pipe cut with the commercial die wouldn't fit. It may be that the claim "just as good"—for straight taps—should be allowed to stand.

The thickness of the body may be increased by shortening the bands, but if carried to extremes, this would hurt the appearance of the banded fitting. The net weight may be increased by using cheaper material, but this would not *improve* the goods, and the quality, fixed by the ever-present need of keeping down the labor cost, is now about as poor as it can well be. Iron fittings must be soft, and brass fittings must be of a mixture which will cut smoothly, in order that the cost of tapping may not be increased by spoiled work. Labor cost saved by improved facilities, is frequently expended in increasing the weight, and thus causing greater sales. Some customers may demand that the material used show a certain tensile strength; this would, in most cases, mean better material, and the customer expects to, and does, pay a better price. Again he may require that they be tested up to some stated pressure, which would raise the price by causing the rejection of some pieces, not for lack of strength, but because of holes through the castings. If the test is made by water pressure, the fittings unable to stand the test at first will often be found, upon testing again after some hours, to be perfectly tight; the holes, too small to be seen until located by the test, after the first wetting, are soon closed by rust. Natural gas fittings are often tested to 1,000 pounds, and, to prevent leakage through the casting, they are boiled for hours in paraffine.

In brief, the qualities demanded by the trade have placed the ordinary fittings far above any theoretical strength, and the efforts to improve these fittings tend, not to change the weight, but rather to a better distribution of the metal, so that when the new fitting is placed on the market, the first and final question, deciding its success or failure, will be: "What does it weigh?"

* * *

The Patent Office issued 33,514 patents in 1908, and registered 6,029 trade-marks, labels and prints; 22,328 patents expired during the year. The total receipts were $1,896,848 and the expenditures $1,712,303. On January 1, 1909, the Patent Office had a balance to its credit of $6,890,726. The work on that date was current, except in five examining divisions out of 49, and those five have caught up with their work since then. Special attention is being directed to the classification of the 915,000 United States patents, the 2,000,000 foreign patents, and the 85,000 volumes in the library, which is expected to reduce the expense of examining applications by one-third, and to improve the character of the work. Commissioner Moore has requested Congress to use a part of the surplus earned by the Patent Office for the erection of a building suitable for its needs.

* * *

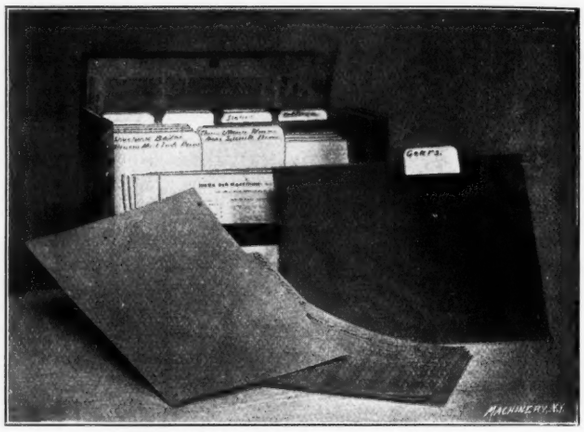
A sensation was created in marine circles by the announcement that the Curtiss steam turbines in the Southern Pacific liner *Creole*, built for the New York and New Orleans service, are to be taken out and reciprocating engines installed in their place. It is claimed that the vessel has not operated satisfactorily; her coal consumption is said to be excessive, 2,000 tons being required for the round trip between New York and New Orleans. The contract with the Fall River Shipbuilding & Engine Co., which built the vessel and turbines, called for a speed of sixteen knots an hour on a fixed maximum coal consumption. The vessel cost about $1,000,000.

MACHINERY'S DATA SHEETS—A WAY TO USE THEM

W. A. WARMAN*

I have preserved and used MACHINERY'S Data Sheets since their inception, and I shall offer a few suggestions from my experience concerning a method of filing them. Binding these sheets is unsatisfactory, as the index is never up-to-date. Again, few if any shops have occasion to refer to all the sheets, and dead material is undesirable, especially if it encumbers live stuff.

The most satisfactory arrangement I have found is that illustrated herewith. This is what is known as a transfer case for the open filing system. It consists of a box 5 by 8 by 10¼ inches, with a cover opening part way down each side, making it very easy and convenient to handle the sheets. The folders shown are made of heavy manila paper with a tab on one side. For convenience, these tabs are staggered. The folders can be made with three or five tabs if desired. The guide cards, with white tabs, are of heavy binder board. As shown in the illustration, the tabs are located on the guide



Filing Case for Machinery's Data Sheets

cards so that four extend across the filing case. Those on the folders are wider, being about one-third the width of the case.

The operation of the system is as follows: Divide the box into subjects with the guide cards, and subdivide the subjects with the folders. For instance, when filing the data on gears, mark a guide card *gears*. Then mark a folder *bevel*, one *miter*, one *spiral*, one *spur*, one *worm*, etc. The sub-classifications may be carried to any extent required for convenience. By this method the indexing is done once only, and the index is always up-to-date. The data pertaining to a class of any subject are in a folder convenient to handle, and fresh material is so easily added that special tables and data pertaining to one's own line may be made on standard size sheets, and inserted in the folders. Such sheets greatly increase the value of the outfit as a time saver.

MACHINE SCREW TAP AND BODY DRILL SIZES

Size	Threads per inch	Body Drill	Tap Drill	Size	Threads per inch	Body Drill	Tap Drill
2	56	43	48	8	32	18	28
3	48	38	44	10	32	9	20
4	46	32	41	12	24	1	15
5	40	30	36	14	20	c	10
6	32	28	33	14	24	c	6

I had a set of sheets shellaced for use in the shop. The shellac keeps them quite clean and they can be washed when soiled. After using the shellac, I found that celluloid lacquer was much easier to use. It may be applied directly to the sheets, while to avoid discoloration, they must be sized before shellacing.

As to the Data Sheets, most all that we have used have been very satisfactory. The only one on which I would suggest a change would be the tap drill list for machine screw taps. The list given herewith is very near for average machine shop work. It is certainly healthier for taps than the

*Address: Keller Mechanical Engraving Co., 570 West Broadway, New York.

list given on Data Sheet Number 2. To devise a tap drill list with which an amateur cannot go wrong, would be an almost impossible task; so many factors need to be considered in determining the drill size that will give the best result. I do not see how any table of sizes for small taps can be used without variation, as conditions vary. The best one can do is to compromise.

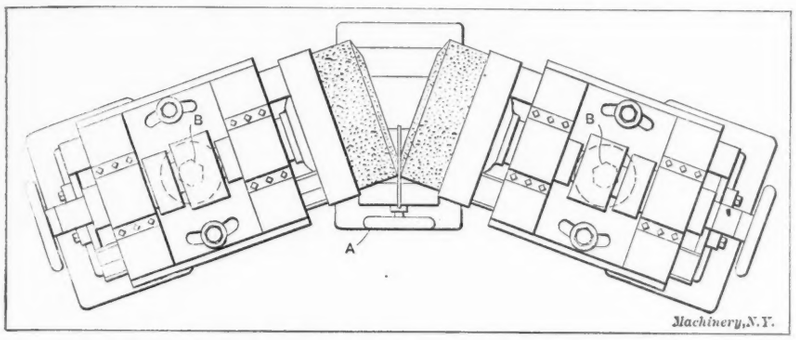
If a screw has little to do, what is the use of taking a chance of breaking a tap by forcing it to cut a full thread? The kind of materials must always cut a large figure in determining drill sizes.

* * *

GRINDING MACHINE FOR SKATES, ETC.

A machine that will grind metal bars on both sides simultaneously has been patented by Chetwood Smith of Worcester, Mass. (U. S. patent No. 930,626, Aug. 10, 1909). His machine is particularly adapted for grinding the blades of skates or in the formation of tools where the sides are to be tapered or ground on a curve.

Mr. Smith found that for successful operation, the axes of the grinding wheels should be at an angle to each other, as shown in the engraving, which is a plan view of his machine. The wheels are cup-shaped and beveled at their working edges to present frusto-conical grinding faces. The axes of the wheels are set at such an angle that the adjacent portions of the grinding faces are substantially parallel when the wheels are employed to grind the blade, the blade being supported on a rest which is made vertically adjustable by the hand-wheel *A*.



Grinding Machine for Skates and Other Parts Finished Simultaneously on Both Sides

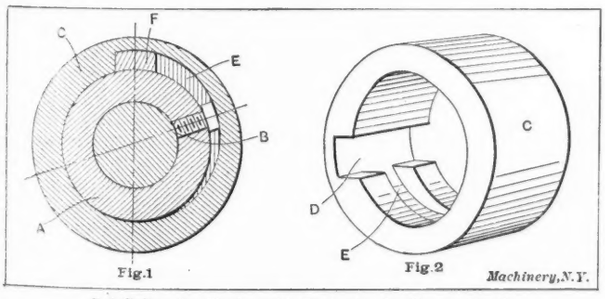
Each carriage has at its under side below the stud *B* a threaded boss and screw with a hand-wheel, which adjusts the carriage longitudinally of the base of the frame, thus adapting the grinding faces of the wheels to the thickness of the work or compensating for the wear of the grinders.

* * *

SET COLLAR FOR SHAFTS

A set collar with an effective retaining means, whereby the danger of its becoming loosened upon the shaft is eliminated, was patented by Israel W. Exley of Colville, Washington. (U. S. patent No. 930,169, Aug. 3, 1909.)

Fig. 1 is a cross-section of the assembled device and Fig. 2 is a perspective view of the locking collar.



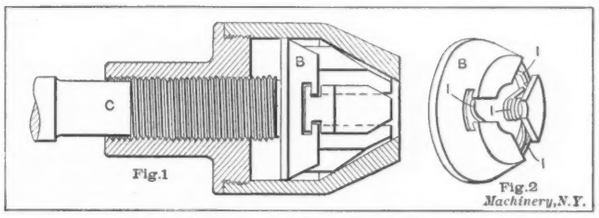
Set Collar for Shafts with Protector for Screw Head

After collar *A* is fastened upon the shaft by the retaining element *B*, collar *C* is slipped over it, the longitudinal opening *D* in the latter coming over the projecting head of *B*. The collar is rotated, bringing the head within the annular passage *E*, which has walls diminishing from its point of connection with the surface of the longitudinal passage. A wedge *F* is then inserted in *D*, and the collars *A* and *C* are thus securely locked upon each other, and the retaining element *B* effectively locked and held in position on the shaft.

* * *

DRILL CHUCK

Thomas J. Fegley and George O. Leopold in U. S. patent No. 932,259 (Aug. 24, 1909), assigned to North Bros. Mfg. Co., Philadelphia, Pa., describe a simple and cheap chuck that will readily and firmly grasp a drill or other tool. A longitudinal section is shown in Fig. 1 and a perspective view of one of the jaws in Fig. 2.



Drill Chuck with Radially-acting Jaws

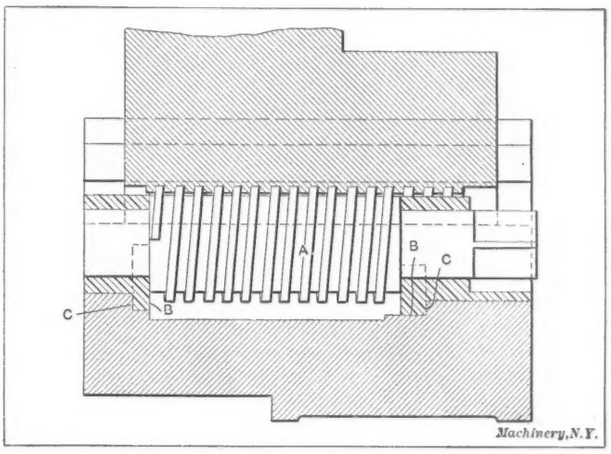
The operation of the chuck is as follows. On screwing the stem *C* into the shell, the disk *B* is forced toward the conical portion of the shell, which, in turn, forces the jaws toward each other against the pressure of the springs *I* (Fig. 2), closing the jaws upon the drill inserted in the chuck. By reversing the movement of the shell the jaws are released from pressure and the springs *I* will force them apart.

By making the disk hollow (Fig. 2) and mounting the springs on studs, the springs are held in position even when the chuck is dismantled.

* * *

CHUCK JAW SCREW MOUNTING

In U. S. patent No. 930,075 (Aug. 3, 1909) Albert P. Kern describes an improved mounting for the radially adjustable jaws of a chuck, which he has assigned to the Cincinnati Chuck Co., Cincinnati, O. The engraving is a section of one of the jaws, showing the operating screw *A*, and the sleeves Mr. Kern uses for bearings. The sleeves are of hardened steel, each having a flange *B* engaging against the shoulder *C* of the body to prevent the sleeve from being radially displaced in its seat. Preferably the outer sleeve has a portion of its periphery cut away for providing clearance for the sliding jaw. The ends of the screws are thus given a hard steel bearing in the radial slot, so the greatest possible efficiency may be derived.



Hardened Chuck Jaw Screw Mounting

* * *

The government of Western Australia is about to undertake the construction of a railway line, 114 miles in length, connecting the Pilbarre goldfields with Port Hedland.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1909

PAID CIRCULATION FOR OCTOBER, 1909, 21,196 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

INDEX FOR VOLUME XV

MACHINERY was started September, 1894, the first volume containing only 192 reading pages and about the same amount of advertising. The fifteenth volume contains 1,000 reading pages and more than double that number of advertising pages. While the growth of MACHINERY has been somewhat unusual in the history of trade publications, it measures quite accurately the growth of the machine tool and kindred industries which the publication represents.

The index for Volume XV, engineering edition, comprises over 4,000 references and fills seventeen pages, type size slightly larger than the regular MACHINERY page, set in six-point, four columns to the page. Copies of the index of the engineering, railway or shop edition will be sent to subscribers on request.

* * *

PROGRESS IN SAFEGUARDING MACHINERY

The promoters of the national movement for providing safeguards for the dangerous parts of machinery to prevent the many distressing accidents to life and limb, should be gratified by the material improvement in this detail noticeable in machine design in the past two or three years. Comparatively few builders of engine lathes, for example, now neglect to cover the back gears and other gears with guards. The appearance of the lathe is improved, and a potential danger to the fingers of the operator is removed.

Purchasers of machine tools can materially accelerate the movement by insisting that all danger points be safeguarded. There is scarcely ever a good reason why gears should not be covered. A pair of spur gears is about the wickedest combination for mutilating fingers that can be conceived of; why should they be left uncovered when so dangerous? The proper shielding of all moving parts that can be covered without interfering with the function of the machine is essentially the designer's duty, and it should never be done as an afterthought when avoidable. This costs less in the original design with which it can be made harmonious, and what is most important, the guards integral with the machine cannot be readily removed by the workmen. Many machines have been wrecked or put out of commission for several days by having clothing or tools accidentally drawn between the gears, resulting in bending the shafts and even breaking the frames. By all means provide gearing with suitable covers, harmonious with the general outline of the machine. This remark is addressed to the designer.

* * *

LEARN TO DRAW

Every machinist who aspires to advance himself in his trade should learn mechanical drawing, or its rudiments, at least, so that he can make an accurate, understandable sketch. Drawing is a universal language, and the mechanic who cannot read drawings or blue-prints is not of much account nowadays. Picture writing is the earliest known form of written language, and the easiest understood. It is so comprehensive and simple that the most intricate ideas are made clear even to a child who perhaps cannot read. A sketch tells much that cannot be imparted by word of mouth. We never lose our wonder at the miracle and mystery of the repeated line—the repetition of the straight and curved that is the substance of all delineation.

A machinist would be ashamed to acknowledge that he could not read or write, and he should consider that he is equally at fault in his mechanical training if he cannot draw and read mechanical drawings. Drawing is an exceedingly useful accomplishment to a man who has to direct the activities of his shop mates. He can save time and convey clear ideas by resorting to sketches. The record can be made permanent, and is often a convenient reference long after it was made. The man who can make an accurate sketch of a machine part or a mechanism must have an accurate mental picture of it, and that means clear thinking. One great difference in men that makes some leaders and others followers is the respective capacity for thinking. The mere act of drawing accurately will stimulate mental activity wonderfully. It will usually make the individual study to understand things that in his conceit he believed he fully understood before. Drawing in this respect is akin to writing for the press. A man never realizes how little he actually knows of a process, method, or mechanism until he tries to describe it accurately in written words.

* * *

CATALOGUE FILING FOR SMALL CONCERNS

Every concern, large or small, that receives many catalogues listing machinery and other products likely to be useful in its business, should have some systematic method of filing them for ready reference. The average proprietor of a small shop probably will say that it is all right for the big concern to provide a catalogue file but, when you are superintendent, foreman, business manager and office boy all in one, there is mighty little time left for such fol-de-rol. Doubtless there is not much time left for systematic effort in the poorly managed business, but the time wasted in looking through a heap of papers for a catalogue that is dimly remembered and badly wanted will, if rightly directed, more than suffice for properly filing catalogues and price lists so that they can be readily found.

A simple and cheap method of caring for advertising literature is in use in the editorial department of MACHINERY that is recommended to those particularly who cannot afford a more elaborate system. First, a number of ordinary letter files was provided that cost at retail 25 cents each. These files were numbered on the back, beginning with 1 and filled with the catalogues on hand. Each catalogue put in No. 1 file has the number 1 written or pasted on its cover and those put in No. 2 file are marked 2, and so on. The obvious purpose of these numbers is to facilitate replacement in the proper file when removed. The date of receipt of all circulars and other advertising literature is written on them, thus 9/28/09. A card index of 3 x 5 cards is compiled, each concern represented having a card on which is written the number of the file in which its catalogue is stored.

Catalogues are filed as received, filling the new boxes without regard to matter on hand except when new literature from concerns already indexed is received, then the new matter is put in the old box and no change in the cards is made. No attempt is made to file in alphabetical order, but a small concern could preserve the alphabetical order without great trouble, and in that case the card index would not be necessary.

Another means for avoiding the cards is a list of the concerns represented in each file pasted on the back of the files. The common letter files are 10 x 11½ inches inside, and will store the average size catalogues easily, and if a little care is taken each file can be so filled as to leave very little waste space.

* * *

LIGHT AERONAUTIC MOTORS

The aeroplane has been aptly typified as "an engine with wings," meaning that the motor is the heart and substance of the heavier-than-air flying machine. No other vehicle is so dependent on its motive power: A motor boat will still float if its engine is disabled; an automobile may be run off by the side of the road and left until the repair man can be called; a motor-cycle can be propelled by foot power; but the aeroplane must at once leave its element and negotiate the best landing place available when the engine stops. A dependable motor is so necessary to the success of the flying machine that we are forced to conclude that until it has been developed into a perfected state the aeroplane will remain little more than a dangerous toy for a few bold experimenters to risk their lives in.

In the race to develop aeronautic motors that will fly, the effort has been made to excel in lightness of construction, and some of the resulting motors have been marvels of power per unit of weight. It now appears, in the light of experience, that the sacrifice of dependability to mere lightness has defeated the object of making a motor that will certainly fly. It is not sufficient that the engine be made so light and powerful that it can easily raise itself; it is of equal or greater importance that it continue in flight and develop full power so long as the operator desires and the fuel supply holds out. One flying machine experimenter says: "Three different types of lightweight aeronautic motors experimented with have proved more than unsatisfactory. While the machine easily flies and rises with each of these motors, none can be depended on to stand the strain of continued operation. This experience forced me to consider the building of a new motive power, meeting more efficiently the requirements of the new art. The manufacturers of the present-day light motor, in an endeavor to lighten the engine, lose sight entirely of the real function of the motor. In an aeroplane, continued, ever-ready and dependable power is more important than in an automobile for a hundred and one reasons."

The experiments of the Wright brothers indicate that very light or very powerful motors are not absolutely necessary. In the official test at Fort Myer, Orville Wright lifted and carried 1,300 pounds with an engine rated at less than 24 horsepower, at a speed of about 45 miles an hour. Comparing this with the Curtiss record at Rheims, France, in August this year (see October number) the difference in weight per horse-power is marked. The Curtiss aeroplane, loaded, weighed about 700 pounds and developed 63 horse-power, the weight per horsepower being about 11 pounds, while in the Wright aeroplane it was about 55 pounds per horse-power. The greater area of wing surface in the Wright machine undoubtedly means that less power is required for sustaining the load.

The correlation of power of the engine, the size and speed of the propellers, and the area and shape of wing surfaces to secure the highest efficiency will undoubtedly require many more experiments than have been made by the Wright brothers and others, and probably some strange discoveries will be made in the realm of aerodynamics.

* * *

CHAIN MAKING WITHOUT SCRAP

Practically all manufacturing operations are accompanied with more or less waste. The turning of logs into merchantable lumber, for example, is enormously wasteful, not 50 per cent of the cubic contents in the logs appearing in the finished lumber when worked up by the machinery in general use twenty years ago. It is true that considerable improvement has been made in eliminating waste since the advent of band saws and thin resaws that convert a much smaller amount of wood into sawdust than the old circular saws of a generation ago, but even with the highly developed modern wood-working machinery the waste still is large, and in the majority of wood-working operations it must so continue except in the case of veneering. So it is in the milling industry, and all along the manufacturing line with a few notable exceptions.

Machine shop operations consist of turning, planing, drilling, boring and milling, all of which remove metal from where it is not wanted, thus making the finished product by wasting material in chips. Cutting, bending and forming is done in presses, however, with little waste, and some press work has been so highly developed as to eliminate practically all scrap. The article on another page of this number (engineering edition) "Chain Making Extraordinary in a Scrapless Press Room" is a notable example in which the elimination of scrap in an automatically formed product has been carried to the limit. While the process is typical of similar processes for the cold conversion of metals in wire or ribbon form into merchantable products, none we believe has equalled this.

To convert a coil of cold steel ribbon into perfect machinery chain, hardened against wear without a particle of scrap except a trifling scallop at each end of the coil, is a triumph of manufacture, and when it is considered that the product is turned out automatically, and the finished chain is 95 per cent of the length of the steel ribbon, we figuratively take off our hat to the man or men who have made this astonishing feat possible. Remember that the product is not the light plumbers' chain made from thin brass stock, but is machinery chain in sizes from ½ inch to 3 inches wide, and in thickness of 0.045 to 0.250 inch. The large sizes are capable of transmitting heavy power.

That man is called a public benefactor "who makes two blades of grass grow where one grew before," and equal justice requires that we acknowledge our debt to the men who have made scrapless chain, screws, nails, and other useful products possible at a labor cost so low as to be almost negligible.

* * *

THE MASSACHUSETTS PLAN FOR INDUSTRIAL INSURANCE

In the August, 1907, issue of MACHINERY, an article was published entitled "Industrial Life Insurance and the Workman." In this article the great waste incident to industrial life insurance, as conducted by the large industrial life insurance companies, was pointed out, and in a short item in the September, 1907, issue mention was made of the law enacted in Massachusetts permitting the savings banks to conduct industrial insurance. It appears that the Massachusetts plan during the two years it has been in operation has proved successful, and many firms and industrial corporations employing great numbers of men have taken active interest in the matter by way of facilitating the spread of information relating to the methods employed by the savings banks. One of the latest large Massachusetts manufacturing corporations to introduce into its plant the plan of savings bank life insurance and old age annuities is the B. F. Sturtevant Co. of Hyde Park, Mass. A savings bank agency has been established within the works, in charge of a person furnished by the savings bank insurance committee of the Boston Chamber of Commerce. As industrial insurance is practically a necessity to the majority of industrial workers, this departure is a very important one, and it is to be expected that this form of insurance will be introduced into other states as well.

Under this system of savings bank life insurance, any savings bank is authorized to establish an insurance department for issuing life insurances, limited to $500 and annuities limited to $200 per year, to residents of Massachusetts. While the amount of insurance in any one savings bank is thus limited, the same person may take out life insurance and annuities in more than one bank. The most important feature of this system of insurance is that the cost is much lower than that charged by the large life insurance companies in the past, notably the Metropolitan of New York and the Prudential of New Jersey. The savings bank industrial insurance is conducted at actual cost, and all profits are returned to the policy holders. The causes of the high cost of the industrial insurance in the large companies has been high managing expenses, which for instance, in the industrial department of the Metropolitan Life Insurance Co. in 1904 were 42.08 per cent of all the premium receipts. In the same year the percentage of managing expenses to the deposits made

during the year in the Massachusetts savings banks was 1.47 per cent. These facts were disclosed during an investigation made in Massachusetts, and as a result of this investigation the law relating to savings bank life insurance was enacted.

Although the general public has not responded as readily to the advantages of life insurance as was expected, the response of the various industrial establishments, where the managements have done considerably towards presenting the advantages of the scheme to the employes, has been satisfactory. A large amount of savings bank insurance has been obtained at the leading shoe factories in Brockton and Haverhill, and at the Fore River Ship Building Co., Quincy, and the United States Shoe Machinery Co., Beverly, Mass. The success has been greatest where the employes are well paid and of an intelligent class. To facilitate making this class of life insurance known to the employes the literature on the subject is usually first distributed in the pay envelopes. After that a trained insurance man from the Boston Chamber of Commerce interviews all the men and women who have shown interest in the subject. The success of the plan has caused considerable interest among manufacturers in other states.

An interesting comparison between the savings bank insurance and that offered by the large industrial life insurance companies is given by the Massachusetts State Actuary in a recent publication, wherein he shows that under this system an old age annuity with the life insurance feature added, costs less than what the working man now pays for his industrial life insurance alone. If a man is twenty-five years old and pays to the savings bank $1.30 each month, and his neighbor of the same age pays $1.35 each month to the insurance company, then the savings bank depositor when he reaches the age of sixty-five will have no more insurance to pay, but will begin to receive an annuity of $100; his neighbor, however, will continue to pay $1.35 each month to the insurance company until he is seventy-five years old, and yet nothing will be paid to him as annuity at any time, but his insurance merely amounts to a given sum payable at death.

Some figures relating to the actual cost of insurance under this system may prove interesting. By paying $1 a month, a man twenty-one years old may secure for himself an annuity of $200 a year, commencing at an age of sixty-five, and continuing throughout life. A man twenty-five years old by paying $1.16 monthly for twenty years may obtain a life insurance of $500. By a payment of eighty-two cents a month for life, he can purchase the same amount of insurance, his family receiving $500 at his death whenever it may occur. Including, as this system does, the annuity plan at an age of sixty or sixty-five years, it is an efficient substitute for the old age pension systems adopted in England and Germany, and instead of making the pensioner a *dependent* for life, this plan makes the man who commences to save a small amount early in life, *independent* in his old age. Under our present industrial conditions the importance of this system can hardly be overestimated.

* * *

An extensive plan for a system of airship lines to be established in France is outlined in *Page's Weekly;* where the capital for permanent structures and equipment is to be had is not explained. In view of the fact that service of this kind can hardly be expected to be financially successful, this most important consideration seems to have been given too little attention. Five airships, it is stated, capable of carrying from eight to twenty passengers besides the crew, will be built, and four lines will be immediately operated. Three stations, it is stated, are practically ready (?), and that of Rheims will be ready within two months. One line will extend northeast from Paris, another southeast to Lyons, another southwest to Orleans, Bordeaux and Pau, and a western line to Rouen. A similar company has been formed in Germany. It is stated by the *Practical Engineer* that the capital is 3,000,000 marks and that two ships are being built by the Zeppelin company, each capable of carrying the necessary crew and twenty passengers, the cost per ship being $140,000. No attempt is made, it is stated, to *estimate the profits:* this seems to be the most sensible part of the venture.

BOARD DROP-HAMMER DESIGN

H. TERHUNE*

About two years ago the writer had occasion to redesign an entire line of drop-forge machinery for a large drop-forge plant in the East, using board drops exclusively. In years past the use of these hammers has been severely (and justly) criticised because of the high cost of upkeep. For some reason the builders of these machines have neglected to keep the design up to the demands put upon the machines. Having been designed mostly for straight work, they often fail when forging four- and six-throw crank-shafts, automobile front axles, or any other kind of work requiring a lot of "break-down" (bending into shape) work.

So serious have been the repair bills on this class of work that many drop-forge plants have adopted the system of using two sets of dies, one to break down and another to finish, so that the impressions in the die blocks can be placed more central in the hammer. This not only entails extra cost for dies, but the tying up of an extra hammer as well; whereas, if the hammer had been properly designed to withstand the additional strains put upon it due to the breaking down, as well as wide enough between uprights, the work could have been done in one machine at a much less cost; the break-down being done at one side, and in the same die block as the finishing impression.

It is the side thrust that causes so much trouble with the piston rod and packing gland of the steam hammer.

Economy of Board Drops

For forgings up to say 300 pounds, the writer does not believe that a more economical way can be found to forge them than in a properly designed board drop hammer. The power consumption is extremely low. In one plant using 45 board drops varying from 400 to 3,000 pounds or a total falling weight of 50,700 pounds, even with a bad arrangement of jack-shafts, these hammers together with 23 trimming presses and kindred machinery are driven by two motors of 75 and 100 H.P., respectively, and yet there is power to spare. For convenience let us assume that 40 H.P.—a low estimate—are used on the presses and other machinery; this leaves 1 H.P. for every 375 pounds of falling weight.

Almost every builder of steam drops recommends a boiler plant of at least 0.75 H.P. for every 100 pounds of falling weight. It is true that a steam drop will do more work in a given time for the same number of pounds falling weight than a board drop, but this is not so important when we consider that the best furnace to-day will hardly keep a board drop constantly going. Besides, what would become of the average drop forger if kept constantly before his fire for a full day of nine hours?

General Construction of Board Drop Hammer

To meet the requirements of an up-to-date drop-forge shop, the hammer, of which a front and rear view are shown in Fig. 1, was designed. It is an almost indestructible machine, the capacity of which seems to be limited only by the ingenuity of the die sinker. In the design many new and commendable features have been introduced.

The bases are of cast iron and in one piece, a weight ratio of 15 to 1 between base and hammer being adopted; that is, if the hammer weighs 2,000 pounds, the base would weigh 30,000 pounds. A shoe or "sow" of 0.45 carbon steel is keyed and doweled into the base, and the die openings planed into this. The recess in the base for the uprights is planed straight through, assuring a permanent alignment, as there is a bearing the entire width of the uprights.

Fig. 4 shows the section of upright used by most builders since board drops first came into use. As work became more and more severe, and uprights failed, nothing was done, however, but to increase the cross sectional area till the center became very porous, an even section of metal being impossible. The V's too have failed, and in every case the break was perpendicular to the surfaces in contact (see Fig. 4). These failures, together with a practical and theoretical knowledge of conditions led up to the form of upright shown in Fig. 5, which has nearly an even section of metal distributed so as to

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better withstand the shocks brought to bear upon it. The V is backed up by a beam of the depth *A* and the thickness *B*, and any direct thrust that is perpendicular to the apex of the V is taken up by beams of depth *C* and thickness *D*.

Adjustments

It often happens in drop forge work that the dies do not match exactly sidewise, and some adjustment is necessary to bring them in line. The top die is generally doweled securely onto the hammer, and some drop forge plants use double keys for holding the bottom die in the shoe. One taper key is driven in from the front, and another taper key is driven in from the rear. In adjusting the location of the lower die relative to the upper one, all that is necessary is to back one key out and drive the other one in. This form of adjustment, however, is rather limited, as the taper of the keys must not be too great, or the keys will not remain in place; it also adds an extra piece to fit and possibly jar loose.

A better method of adjustment is to move the entire upper structure sidewise on the base by means of an adjusting bolt; but this bolt has, possibly, been one of the greatest annoyances of the board drop in years past. For a long period all makers used practically the same construction, consisting of a set-screw passing through a nut inserted in and fastened to the base, the point of the screw bearing against a projection of the upright. The hammering action of the upright, however, is very severe, especially on break-down work, and the point of the adjusting screw soon becomes upset so that it can neither be removed nor used for adjusting the uprights.

In the present construction, therefore, a bolt with a T-head has been laid horizontally in the recess for the upright cast in the base. The T-head is let into the base, so that the bolt cannot move relative to the base casting. The round part of the bolt rests on a finished surface in the recess, and a finished groove is provided in the upright to fit over the bolt; the lower part of the upright thus straddles or forks over the body of the bolt, as shown in Fig. 6. The collar-nut on the end of the bolt is shown at *A* in Fig. 1, this nut bearing against a boss on the upright. One bolt of this kind is provided for each upright. In adjusting, the hammer with upper die is let down until the faces of the dies come together. Then the base binding bolts are loosened, and also one of the upright adjusting bolt nuts. The other adjusting bolt nut is tightened, thus moving the entire upper structure—uprights, hammer and head—to the right or left, as the case may be, until the dies are properly matched. Then all parts are again locked into place. The moving of the entire structure is quite common in board drop hammer designs and is considered good practice, especially when the base binding bolts are at an angle, as is the case in the present hammer, as this

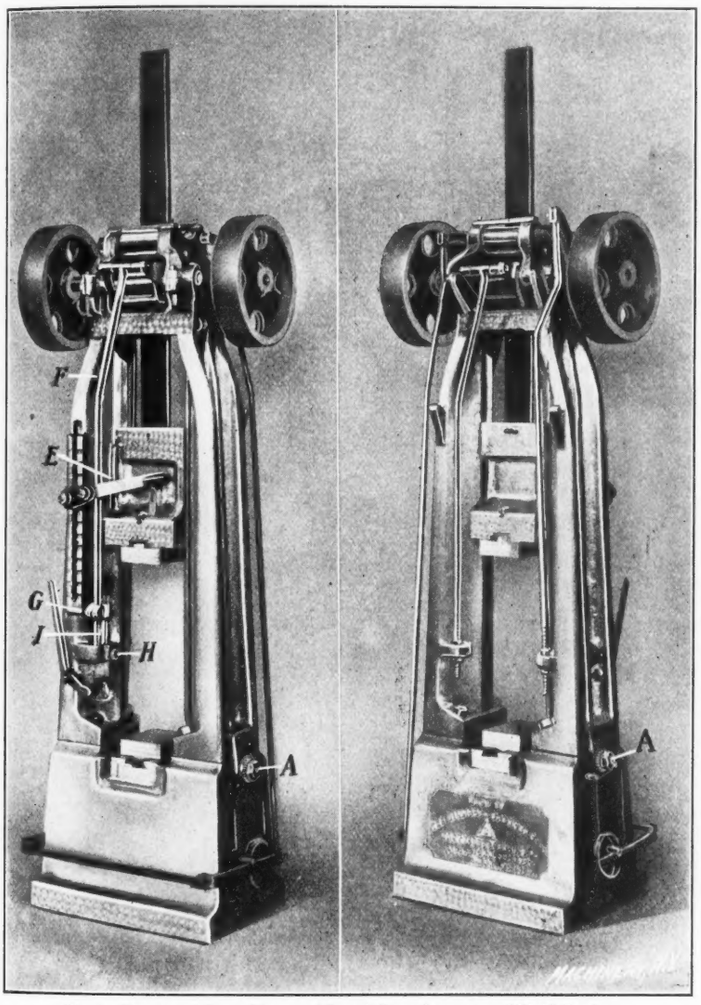


Fig. 1. Front and Rear Views of Board Drop-hammer of Rigid Design

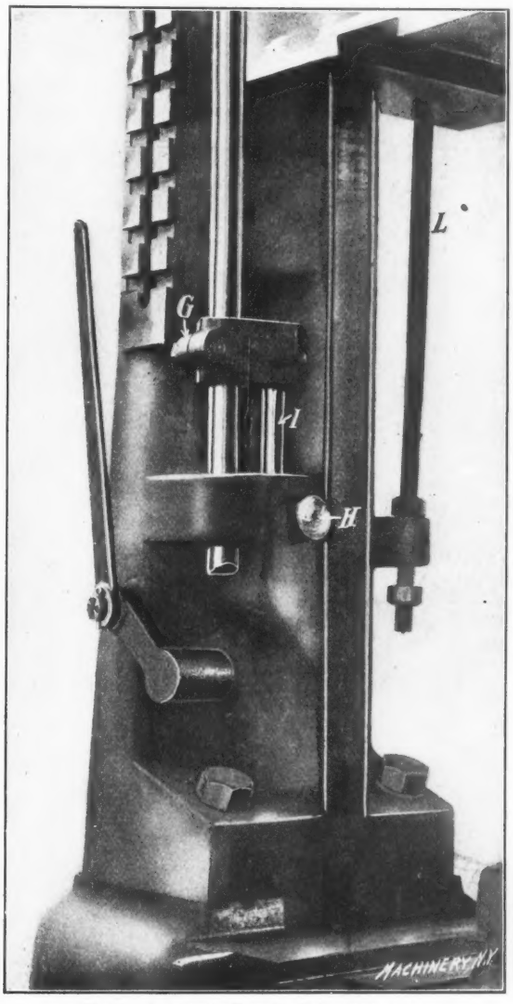


Fig. 2. Automatic Knock-off Arrangement

draws the uprights apart and back against the adjusting bolt nuts.

Notches are cut in the collar of the nut, as shown in Fig. 3, and a flat spring is fastened to the base and brought to bear in the notches, this forming a positive lock and an easy means of adjustment. With a special thread on the bolt, an adjustment as fine as 0.0028 inch can be had.

The trouble due to constant vibration causing the uprights to creep together and pinch the hammer at the bottom is overcome by setting the base binder bolts at an angle, thus keeping the upright back against the upright adjusting bolt nut. The adjustment for different heights of fall is made by a bracket clamped to a modified form of rack in any desired position on the left-hand upright. (See Fig. 1.) The roll releasing lever *E*, better shown in Fig. 7, allows the friction bar *F* to release on the up stroke without shock or noise. The automatic knock-off *H* is best shown in Fig. 2.

Adjustment for different thicknesses of dies is made through the adjustable dog *G*, carrying a stop pin *I*,

the latter resting on a flattened surface of the knock-off *H*, which has an elongated hole through it. The side of the hammer is beveled to fit the beveled end of the knock-off *H*. As the hammer descends the knock-off is forced back, allowing the stop pin to fall through the elongated hole. For thick dies the stop pin is set forward, and, as shown in the line engraving Fig. 8, consequently falls earlier. In this line engraving, *C* is the elongated hole in the upright allowing adjustment for the stop pin; the pin is shown set for thick dies and it is moved back in the slot for thinner dies. The elongated hole through the knock-off is indicated at *D*. As the hammer descends it is evident that when the knock-off is forced back, the stop pin falls through the slot in the knock-off and allows the friction bar to drop, and thus the eccentrics on the lifting rolls are brought into contact with the lifting board. The hammer then rises until the hammer pin, which is made of wood in order to lessen the impact, comes in contact with the roll releasing lever, which raises the friction bar and thus releases the rolls.

As shown in Fig. 8, the stop pin rests on a surface the width of which equals *y*. Should the stop pin be moved to

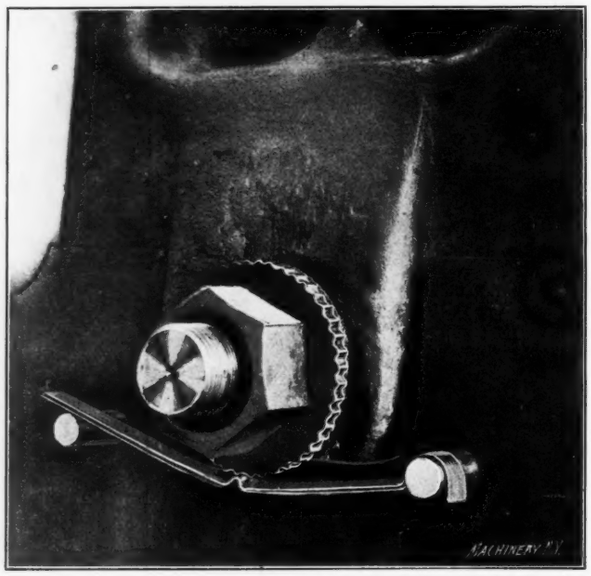
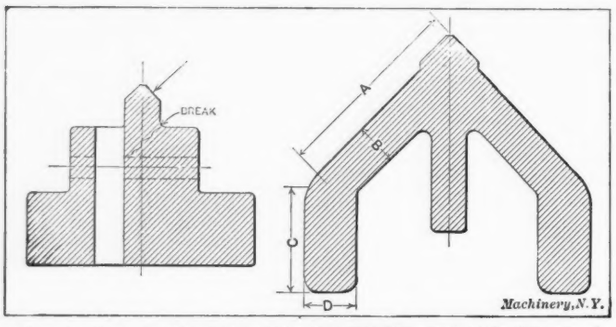


Fig. 3. Locking Arrangement for Upright Adjusting Bolt Nut

the left to the end of the slot in the upright, the knock-off evidently would have to be forced back a distance equal to *z* before the friction bar could fall. As the side of the hammer and the front of the knock-off are beveled only 5½ degrees, the hammer must travel a considerable distance to force the knock-off back 1⅛ inch, which is its extreme travel.

Even if the drop forger is not careful in setting the knock-off, little can be lost in having it act too early, unless



Figs. 4 and 5. Section of Uprights of Usual Type and of the Type used in the Hammer shown in Fig. 1

at a very short fall, because the hammer has a velocity of a free falling body, having fallen several feet, while the friction bar starts from rest when the knock-off releases it. The friction bar should be heavy enough to throw the rolls against the lifting board with force enough to lift the hammer readily. The best condition is to catch the hammer when rebounding from the dies.

It will be noticed that there is no provision made for preventing the knock-off from turning around its own axis. Provision to prevent turning was made on the first hammer built, but it was found unnecessary, as the weight of the friction bar resting on the flattened surface always keeps the knock-off

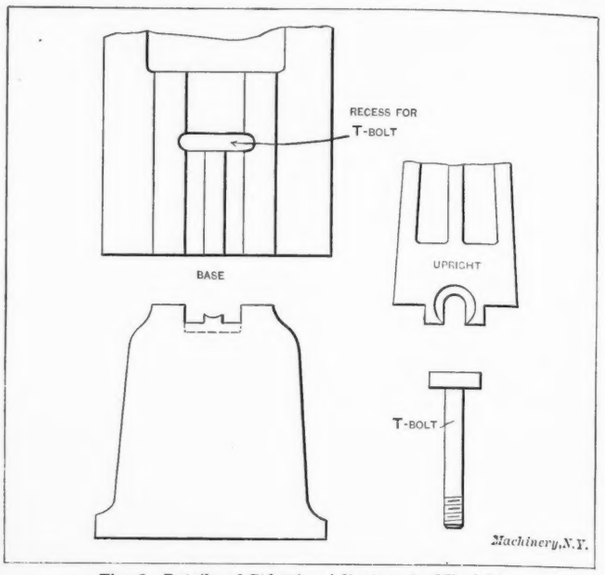


Fig. 6. Details of Sidewise Adjustment of Uprights

from turning when the bar is up, and as soon as released, the pin passes down to the slot in the knock-off, making turning impossible.

The knock-off stop is counterbored instead of being bored clear through. The reason for this is that the impact of the hammer would be likely to shear off the taper pin. With the construction shown, the pin has nothing to do but overcome the impact and pressure of the spring, and even this impact is lessened by fiber washers which act as cushions, as well as by a safety cotter pin which would act in case the taper pin should fail.

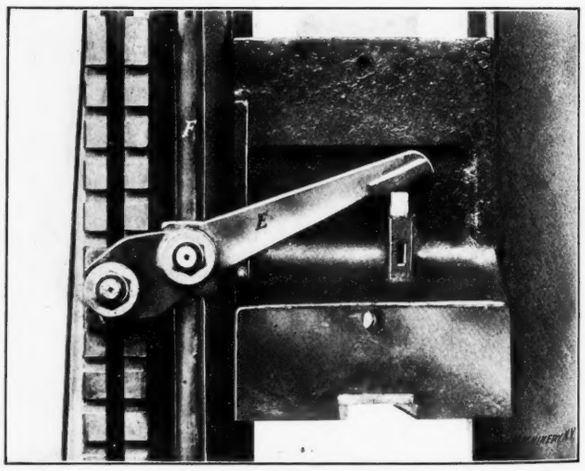


Fig. 7. Arrangement for Adjustment for Different Heights of Fall

When the hammer pin comes in contact with the roll releasing lever, as previously mentioned, thereby raising the friction bar and releasing the rolls, the hammer again falls and will continue to run automatically until the treadle is released. At this time it comes to a rest on the top of its stroke, and is held there by board-clamps *K*, Fig. 9, located above the rolls out of the way of any oil that may work out of the bearings. By a greater or less depression of the treadle, any blow may be struck regardless of the set fall. The hammer can also be stopped at any point when falling, without injury to the machine.

Head Construction

Fig. 9 gives a good idea of the head construction. Both lifting rolls, as well as the board clamps, are mounted on eccentric sleeves, the front one of each being intended for operating and the rear one for the adjustment necessary, due

to the rolling down or wear of the board. This feature is one of the most important in the whole construction as a perfect alignment of the rolls is always assured, regardless of how careless the operator may be. The adjusting bars *L* are carried down in the back of the uprights through lugs cast on them, and locked within easy reach of a person standing on the floor. (See Fig. 2.) Adjustment for the wear of the board can thus be made in a few seconds, whereas usually on all drops offered to the trade a ladder is necessary for reaching the set-screws located behind each end of the rear roll bearing. It is then a mechanical impossibility to ever get the rolls and clamps parallel, with the proper amount of friction, while the drop is running.

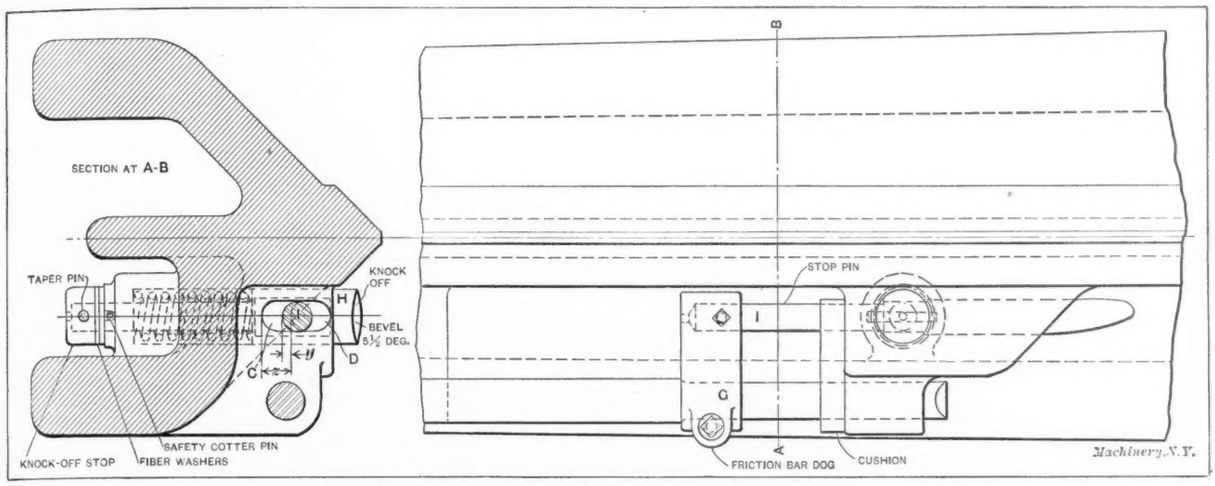


Fig. 8. Details of the Automatic Knock-off Arrangement

An even pressure must be brought to bear across the entire face of the board, or a rapid wearing away will result, and many times this causes it to split. A double pressure on one side also has a bad effect on the bearings.

Seasoned maple boards have been found to stand better than any other kind of wood or metal. Paper fiber has been tried with fairly good results—but as yet the cost of this material is prohibitive. All running bearings of the hammer illustrated are exceptionally long, bronze bushed and provided with large oil reservoirs.

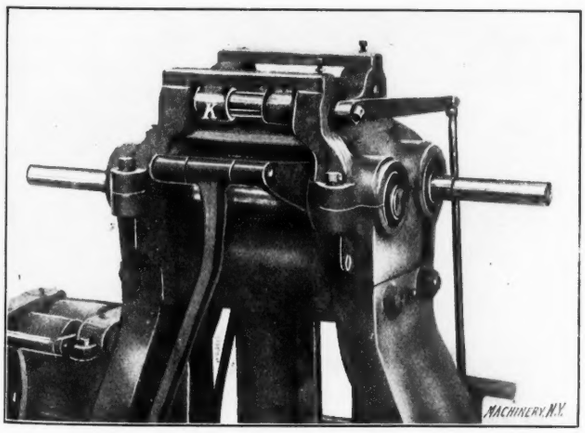


Fig. 9. Head Construction of Board Drop-hammer

Fig. 10 shows the foundation construction, which, like the ratio of 15 to 1 between base and hammer, was adopted after a long and varied series of experiments. The concrete mixture is made up of three barrels of stone, two barrels of coarse sand, and one barrel of cement. To meet the various classes of work that comes into the average drop-forge shop, these hammers were built very wide between uprights, *viz.*, 400-pound hammer, 12 inches; 800-pound, 14 inches; 1,200-pound, 17 inches; 2,000-pound, 20 inches; 3,000-pound, 24 inches. It does not seem practical to build board drops larger than 3,000 pounds falling weight. The field in which heavier blows than this are required is best covered by the steam drop and the hydraulic press.

THE MAKING OF AN ACCURATE LEAD-SCREW

In a paper read before the Institution of Mechanical Engineers, of Great Britain, by Mr. H. F. Donaldson, an incident is related showing the pains which are sometimes taken by mechanical men to accomplish their ends. The author of the paper states that some years ago he visited certain British works where it was claimed that micrometer screws were produced with exceptional accuracy. He there had a conversation with one of the members of the firm who claimed to have produced, by his own efforts, an accurate master screw upon which the accuracy of all the firm's subsequent work of this character depended. This man first cut a screw as accurately as possible by the common methods, and he then shut himself in a room, the temperature of which was constantly kept nearly at the heat of the human body, so as to in this way by artificial means minimize the effect of the heat of his body on the work in which he was engaged. His screw had a square thread and was about twelve inches long;

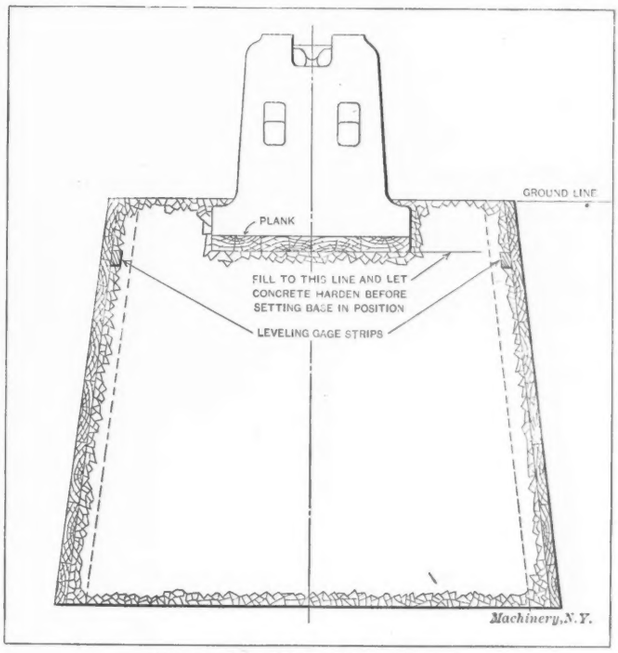

GROUND LINE
PLANK
FILL TO THIS LINE AND LET CONCRETE HARDEN BEFORE SETTING BASE IN POSITION
LEVELING GAGE STRIPS
Machinery, N.Y.

Fig. 10. Foundation of Drop Hammer

when the temperature of the room had been brought to a level as high as he considered he could stand, he shut himself in the room and proceeded to measure short lengths of the whole of the screw and lap the inaccuracies on both sides of the thread until he secured, as near as could be obtained, absolute accuracy in the screw. He remained in the room until he had gone over the whole length of both sides of the thread which required about twenty-four hours, when he came out of the room with the screw in its finished state.

SOME CAUSES OF BELT FAILURES*

G. S. BAKER†

Nearly every large manufacturing plant is constantly making changes and improvements in its machinery for the sake of effecting greater economy in its output. Strangely enough, many of our largest manufacturing plants, though equipped with most modern machinery, have most inefficient methods of installing belting equipment. There seems to be a general feeling that belting a machine is something that everybody understands and something which needs no particular study or attention. The result of this indifferent attitude toward belting and its proper installation, has been constant extravagance in the belting equipment of plants where the greatest possible economy is followed in other directions.

The causes of belt failures are many. In some instances the cause may be traced direct to the manufacturer of the belt, who has not furnished in the goods delivered the qualities which he should. But, let us assume, that only the best belting is bought and delivered, and then analyze why the best belting, wrongly installed, will have need for frequent replacement. Under such conditions the causes are two-fold: First, belt failures are often due to a defective working out of the underlying principles of practical belt transmission; and second, belt failures are often the result of the selection of an improper type of belting for the particular kind of work to which it is to be put.

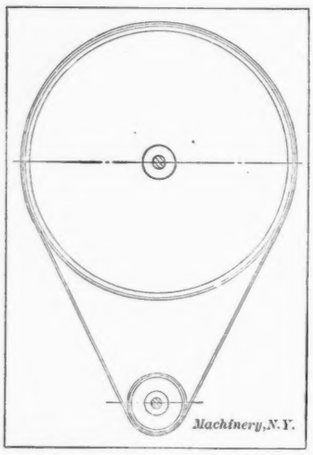


Fig. 1. Drive from Large to Small Pulley, showing Decreased Arc of Contact

We shall, in this article, attempt to show how a large percentage of the unnecessary costs of belting could be eliminated by following out three suggestions: First, by foreseeing and modifying the mechanical and architectural plans in the building of plants, so that they will conform to the most modern principles of practical belt transmission; second, by modifying pulley conditions in a plant already built; and third, by the selection and proper installation of the right type and size of belting for the particular machine and pulley upon which the belt must operate.

Very often slight changes in transmission conditions would save great losses of time on many types of machinery in many of our factories. Here for example are some of the common mistakes in transmission which could easily be rectified, if attention were called to them.

Allowing too short centers between the shafting. This practice works havoc with the belt where the load is heavy. Owing to its limited length, the belt does not sag on the top side, as it would when driving from the bottom of the pulleys, which is the correct way; therefore it becomes necessary to draw the belt very tight to avoid slippage, thus straining it and adding to the frictional resistance in the bearings. When the diameters of the driving and driven pulleys differ to any extent, as shown in Fig. 1, there is a material reduction in the arc of contact on the smaller pulley, as the distance between the centers of shafting is lessened, and as the driving power of the belt, in a measure, depends upon the area of contact between the belt and pulley surfaces, the advantage of increasing the distance between centers is apparent.

Installation of pulleys which are too small. A slow-running belt must be heavy if any strain is put upon it. It must also be wide to get the proper area of contact to insure it against slippage. Where small pulleys are used, the above condition is doubly true. Were the pulleys at their installation enlarged proportionately, they would still give the same number of revolutions, but the belt speed would be increased, the grippage area increased and a narrower and lighter belt could be used. Such a belt will invariably outlast a shorter, heavier and thicker belt. In determining the minimum diameter of pulleys to be used with single and double belting, it is necessary to take into consideration the width of the belt to be used, belt speed and horse-power transmitted. In a very general way it may be said that it would be well, whenever possible, to have the pulleys on which single belting is to run not less than 8 inches in diameter, and those for double belting not less than 12 inches in diameter.

The avoidance, as far as possible, of quarter-turn drives. Quarter-turn drives (Fig. 2) bring about one of the hardest conditions found in belt transmission. This character of drive can often be avoided in one of three ways: (a) By installing two loose pulleys so that the belt will operate over them, as well as over the regular driving pulleys, as shown in Fig. 3. The loose pulleys must correspond to the tight pulley on the same shaft, and be so placed that the crowns of all four pulleys in plan would form a rectangle. The advantage of this arrangement, generally speaking, may be said to be in the fact that when the belt operates at a quarter-turn with the delivering faces of the driver and driven pulley plumb, the belt does not get the full degree of contact with the pulley which it does with the loose pulley arrangement, which gives for pulleys of the same size a full 180 degrees contact. This condition, of course, makes for greater driving efficiency of the belt than when the area of contact between the pulley surface and belt is lessened by the quarter-turn arrangement.* (b) By the use of a right-angle transmitter. (c) Possibly by installing two idler guide pulleys on the top side of the belt.

An avoidance of the use of small pulleys on extra long center drives. This condition taxes the tractive power of a belt to the utmost. Under such conditions it is necessary that the belt be kept under a certain tension at all times. The result of this is usually either constant taking-up during damp seasons, or lengthening in dry periods.

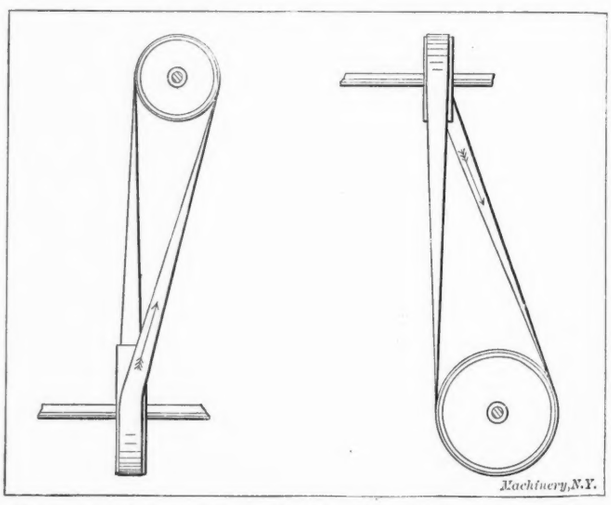


Fig. 2. Quarter-turn Drive showing Distortion of Belt as it leaves Pulley

By so installing the belt that the slack side is above and the driving side on the bottom of the pulleys. If this condition is reversed, the slack side being below, as shown in Fig. 4, the arc of contact of the belt with the pulleys is materially lessened.

Types of Belting for Different Classes of Work

Perhaps the most common cause of wastefulness in belt transmission is the selection of improper types of belting for particu-

* For additional information on this subject, see the following articles previously published in MACHINERY: Apparatus for Measuring the Slip of Belts, May, 1908; Loss of Velocity Ratio Due to Belt Elasticity, January, 1906; The Manufacture of Belting at the Schieren Factory, May, 1906; Tests of Belt Preparations, March, 1906; Horse-power Transmitted by Belts, July, 1906; Belting, June, 1905; Belt Drive for Shafts at Right Angles, June, 1902; Belt Drive for Three Pulleys, March, 1901.

† Address: 51 Beekman St., New York.

* Where the quarter-turn drive cannot be avoided because of lack of room or for other reasons, the straining of the belt can be minimized by lacing the joining ends so that the flesh side of one and the hair side of the other is out. This method was described in the February, 1899, number of MACHINERY. As will be understood, when a belt is placed over the pulleys in this way it is not twisted any more than with the common arrangement, for what was a quarter twist one way becomes a quarter twist in the other direction when the belt end is turned half way around. The advantage of connecting a quarter-turn belt in this way is that there is equal stretching of the belt on both sides, as a given point on one side of the belt is first on one side and then the other of the pulleys for each revolution, whereas with the usual arrangement all the stretching occurs on one side.—EDITOR.

lar classes of work or machinery. We cite in the following a few instances where practical mechanical knowledge of conditions should govern the selection of the belting.

Drives with varying loads should be equipped with belts that have an abundance of elasticity and which are capable of retaining it. The elastic qualities should be such that upon the relaxation of the load, the belt will go back to its original state. Another instance where elasticity has great bearing upon the selection of the proper type of belting is in connection with quarter-turn belts. Here the belt must be able to form a long side and yet be elastic enough to insure of it not becoming permanent.

On drives where there is a long distance between centers, it is necessary that the belt be absolutely uniform and have

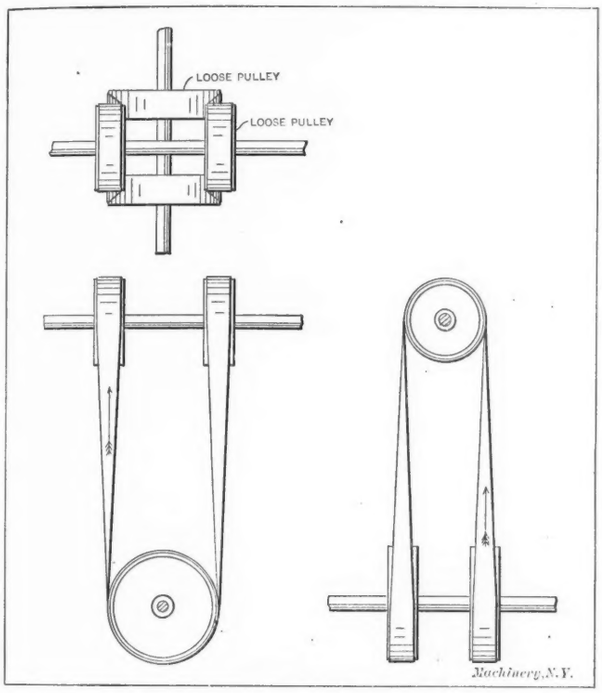


Fig. 3. Four-pulley Drive for Eliminating the Quarter Turn

perfect balance throughout. Unless a belt is procured which contains these qualities, its tractive powers and its driving powers will be materially reduced. Its life will be short and it will be continually running off the pulleys. Nothing but the best woven types of textile belts should be used on this character of drive, or leather belts made from absolute center stock. Often textile belts are selected for use with shifters. This is a mistake and should never be done, unless roller shifters are used. In the event that a belt is wanted which is to carry a heavy load, and where it is necessary that the belt should be kept tight at all times, it is always well to select a belt sufficiently heavy to give it a large factor of safety with regard to tensile strength.

As to the Arc of Contact

On the drives where the arc of contact that the belt has with the pulley is small, the transmitting efficiency of the belt will depend mostly on its width, since only in this way can an approach be made to the proper area of contact. Tensile strength, under these conditions, has very little to do with the horse-power the belt will transmit. The horse-power depends almost wholly upon the speed at which the belt travels. The area of contact of the belt with the pulley should, however, be large enough to prevent slippage.

Starting Machines with Full Load

One blunder very often made by the engineers of large plants, which plays havoc with the belting, is the starting up of machinery with the full load on. The belting is then required to transmit at a speed of, say, 100 feet per minute, the full amount of horse-power that it was designed to carry when running at a speed of, perhaps, 2,500 feet per minute. Unnecessary strains of this sort are among the prime factors which cause belting to go to pieces.

Effect of Water and Dampness

Another condition which is a large factor in belting difficulties, is water and dampness. To meet conditions of this sort, selection of the proper type of belting is of first importance. Dampness is, without doubt, the cause of more belt replacements than any other condition. While water itself may not splash on the belt, or the room in which the belt is operating may be free from water, nevertheless the action of dampness will often work havoc with belting. Dampness, unless the leather is specially treated to withstand its action, will cause the very best of leather belting to stretch, run crooked and in many cases open up the laps and piles. Belting at rest is affected much more by the action of moisture than when driving, as the frictional heat generated by the belt when driving tends to keep the belt dry. The problem of water-proofing and damp-proofing belting is a very important one at the present time, as our largest factories at the present day are being constructed of reinforced concrete and cement blocks. It is a well-known fact that unless special precautions are taken, as is seldom the case, that it is next to impossible to keep a factory constructed in this manner free from dampness, especially in warm seasons when no heating system is in operation. Since so many of our factories are being constructed in this manner, it means practically the dawning of what may be termed "the water-proof belting age." Dampness will penetrate readily through concrete walls. In one instance, which the writer recalls, underground concrete conduits were built in which the driving pulleys were to operate. The object of this idea was to save space by putting these belts under the floor, and also to get solid bearings for their shafting. The superintendent of this factory desired to use untreated, flat leather belting. He claimed that there would be an absence of water and moisture in conduits of this sort. It worked out, however, that the dampness from the ground penetrated the concrete walls and made the place very unsuitable for belting which had not been specially water-proofed.

As to Fasteners

Seldom does the question of belt fasteners receive the attention that it deserves. Almost invariably the complaint registered against the belt because it has torn out where joined, reflects more upon those who had charge of the installation than upon the belt with which fault is found. In determining the type of fastener to use, consideration must first be given to the mechanical conditions under which the belt will operate. If it runs under a tightener or drives from both sides it fol-

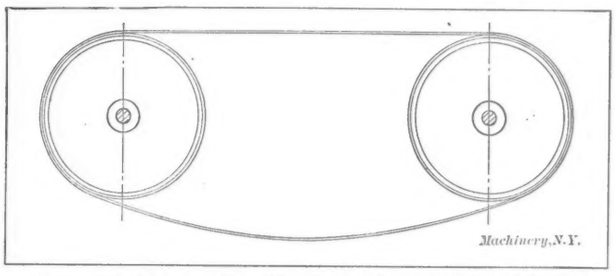


Fig. 4. Belt driving on Top Side, showing Decreased Arc of Contact

lows that the joint must be of the hinge or flexible variety, or the belt made endless, and under these conditions we must eliminate from consideration some types of fasteners which are very satisfactory where the belt operates on free open drives. In the selection and application of fasteners, textile belting calls for even more care than does leather. The punching of a hole which is too large or too close to the end frequently results in the fastener tearing out. In punching a hole in leather belting you weaken it only to the extent of the material removed, but a like operation on textile belting goes further in that it severs many of the interwoven strands and weakens the construction. The aim, therefore, should be to make the holes as small as possible and to place them at regular intervals. In preparing the ends of a belt for lacing or fastening, invariably use a square so that the ends will be at right angles with the edges of the belt. It has often been found, where fasteners do not give entire satisfaction, that this condition was due to the fact that the ends had not

been cut true, consequently, when joined together, the strain was not evenly distributed across the width of the belt, falling more on some points than on others and resulting in the tearing out of the fasteners.

As to Belt Dressings

If a belt does not operate properly or does not seem to grip the pulleys as it should, the average shop superintendent gives the belt a generous dose of belt dressing. It is the writer's belief that as a general thing belt dressings do little good and tend to shorten the life of the belting. In most belt dressings a certain amount of resin is used and in almost all dressings some form of graphite. While both of these compositions possess certain adhesive qualities, in time they are bound to ruin the fiber of the leather. If leather belting is properly curried, it seldom becomes hard or dry, unless it is working under conditions where it is impractical to install a leather belt. In practical experience, it has been found advisable, under such conditions, to use as a belt dressing tallow mixed with a certain amount of castor oil. The tallow softens the fibers of the leather and the castor oil restores to a large extent the adhesive qualities in the belt. But even this most harmless type of dressing should be used sparingly, or the result will be a stretching of the leather. Where trouble is experienced through slippage of the belt, a few drops of castor oil on the pulley where the slipping occurs will be found to give good results. The oil will not injure the leather to the extent that most dressings will. Most all the slippage of belts is due to the fact that frictional heat causes the grain or pulley side of the belting to become dry. Castor oil tends to soften the grain and reduce slippage. Belt dressings, if not used very sparingly, in places where there is a certain amount of dust in the air, will invariably clot on the belt and cause it to run unevenly.

General Service Conditions

The problem of selecting a proper type of belting for different classes of work is one that requires careful study and much experimenting on the part of those who operate different classes of machinery. Considerable money could be saved in belt replacements if the type of belting best adapted for the place were used. The writer knows of many instances where for years leather belting had been used on some particularly difficult drive, where it had an average life of only from two to three months. After allowing this condition to continue for years, the factory superintendent would finally instal some other type of belting which would be found to last much longer than the leather belting. This condition works both ways. Most of the largest belt manufacturers have experimented with different types of belting on different classes of machinery and are able to give authoritative recommendations as to which type of belting will prove most economical for each machine. Such recommendations should receive careful attention with a view to economies. The problem of properly belting machinery is a large one. New types of belting, new methods of fastening and new types of belt dressings are being introduced almost every day. While the proposition of belt transmission is an old one, there is still much room for improvement and need for closer attention on the part of those who use belts.

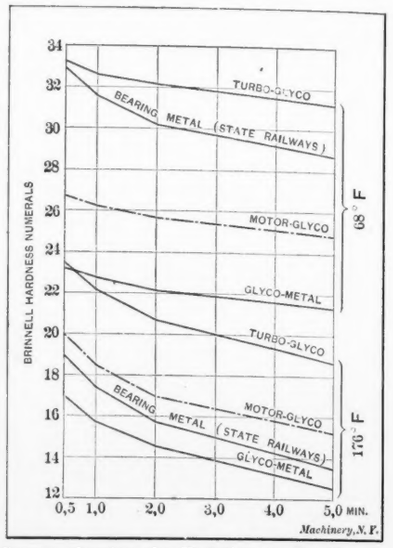
* * *

A NEW METHOD OF GALVANIZING

A new method of galvanizing has recently been patented by George L. Paterson, Thomas L. Mornes and Carl H. Zieme of New Castle, Pennsylvania. The iron or steel to be galvanized is first coated with a paste composed of 88 parts of zinc flue dust, 2 parts of lamp black and 10 parts of clay. These ingredients are mixed with water and applied to the cleaned surface. The material is then placed in a furnace and heated to a temperature of from 600 to 1,000 degrees F. The heating is continued from one-half to four hours, when the article is removed from the furnace and allowed to cool in a place free from oxidizing influences. The paste, now dried, is easily removed, but the surface of the iron or steel is coated with zinc. The inventors claim that the coating thus produced is superior to that obtained by "sherardizing," and that much less zinc dust is used. From a sanitary point of view, the process is also commendable, as the operators are not subjected to the influences of the dry zinc dust.

THE TIME ELEMENT IN HARDNESS TESTS BY THE BRINELL SYSTEM*

A diagram indicating the effect of the time element in hardness tests made by the Brinell method is given in the September 25, 1909, issue of the *Zeitschrift des Vereines deutscher Ingenieure*, and is reproduced in the accompanying engraving. The tests were made by the German Glico Metal Co. On the lower scale in the diagram is given the time, in minutes, during which the pressure on the metal was permitted to act, while the scale on the left-hand side gives the hardness numerals according to the Brinell hardness scale. It will be noted that the longer the pressure was permitted to act, the greater was the impression made on the metal, so that a lower hardness numeral resulted. Two sets of curves are shown, one with the metal heated to 176 degrees F., and one with the metal at 68 degrees F. It is interesting to note that the curves in each set are almost parallel, except in one case, thus indicating that for *comparative* purposes the Brinell test is accurate no matter what the length of duration of pressure, provided, of course, that the various samples tested are all subjected to pressure for the same length of time. It is also interesting to note the difference in the hardness of the metal brought about by the change of temperature. It will be seen that at the higher temperature its hardness numeral is not only less than at the lower temperature, as, of course, would be expected, but when the pressure on the metal is permitted to remain for a longer time, the metal apparently gives away much easier to continuous pressure when heated than when at a lower temperature. Tests of this kind should be of great value in determining the relative value of bearing metals which for long periods are to be subjected to heavy pressures under increasing temperatures. A new factor in hardness testing is also introduced, which the Brinell method is particularly adapted to measure, *viz.*, the power of resistance to *continuous* pressure of various metals, a factor which may be found to vary considerably for different materials.



Curves showing the Variation in Results obtained in Hardness Tests of Varying Duration

* * *

An apparatus was exhibited by Mr. S. H. Schneider at the meeting of the British Association for the Advancement of Science at Winnipeg, which seems to claim the distinction of being a new *perpetuum mobile*. The apparatus, which was not satisfactorily described, consists of a collapsible air-tight box which, when closed, sinks in water by its own weight. On reaching the bottom it is expanded by a magnet, when, being lighter than the water displaced, it rises to the surface where it again folds up and sinks. The inventor states that a full-sized generator weighing 600,000 pounds and displacing 10,000 cubic feet of water would generate 50,000 horse-power at practically no cost of operation. Surely the millennium is fast approaching!

* * *

To prevent the formation of rust inside boilers, experiments have been made at the Berlin Technical Institute, Germany, to use water deprived of the air it contains by means of charcoal. Sacks of freshly prepared charcoal have been put into the water from which the boilers were fed, and the decrease of rust in the boilers fed with this water has been about twenty-five per cent.

* See MACHINERY, September, 1908: The Brinell Method of Testing the Hardness of Metals.

ASSEMBLING A 24-INCH ENGINE LATHE*

ALFRED SPANGENBERG†

While the problems encountered in assembling engine lathes are not as difficult of solution as those met with in assembling machine tools of a more complicated nature, thorough and careful consideration of the methods employed is essential in order to minimize the cost. The most important operations involved are the scraping of the bed and carriage and the lining up of the head- and tail-stock. To a large extent the cost of these operations is dependent on the accuracy of the machine work.

It is the object of the present article to discuss the methods employed in machining, and to illustrate and describe the erecting process on the bed, the principles involved in assembling the units having been fully outlined by the author in previous articles in the September and October issues of MACHINERY. For the purpose of giving a concrete example, a 24-inch engine lathe with quick-change gear device is selected, the general features of which are shown in Fig. 1.

Planing the Bed and Carriage

The practice of some makers to rough out the surfaces to be planed on the bed and carriage, and allow them to season before taking the finishing cuts is indicative of the modern tendency toward accurate machine work as a means to avoid unnecessary scraping. The seasoning process simply consists in letting the casting stand in some convenient place in such a way that it will not be subjected to any outside forces, and allowing the stresses in the casting itself to become equalized.

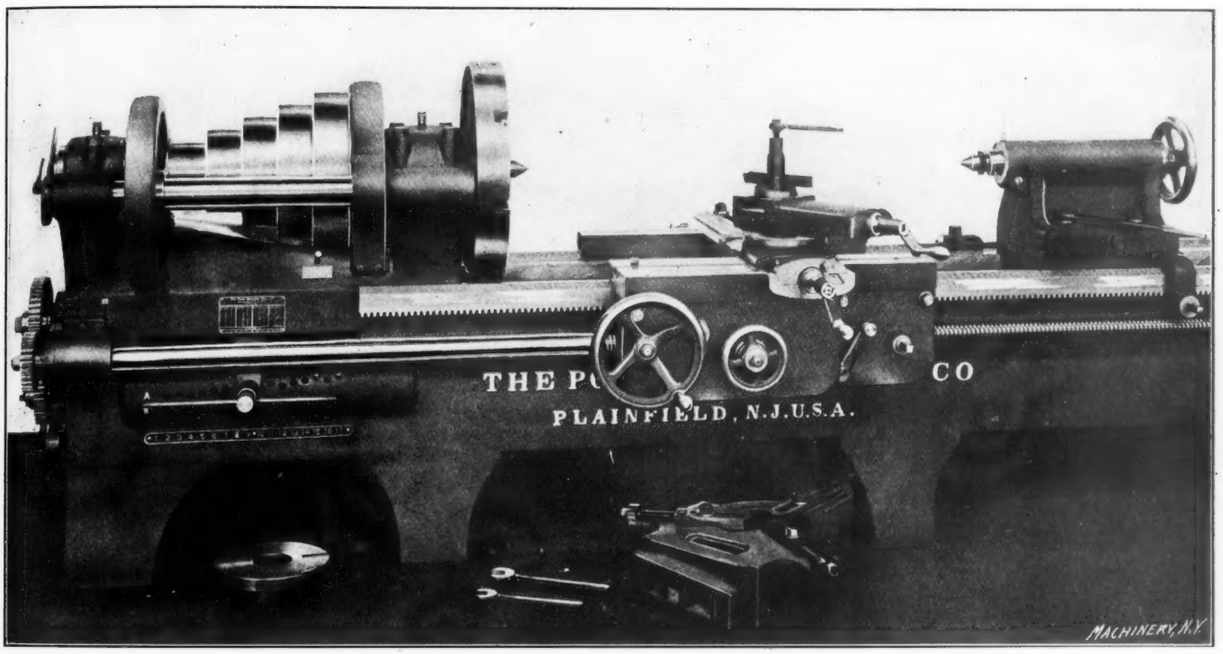


Fig. 1. Twenty-four-inch Engine Lathe with Quick-change Gear Device

Next in importance to providing accurate planers on which to machine the bed and carriage, is the necessity for gages that will enable interchangeable work to be produced. The gages shown in Fig. 2 are particularly well adapted to this class of work, and are far superior to the common type having a bearing on both sides of each V. Feelers or thickness gages are used in connection with the gages illustrated, in order to measure the amount of error. The advantages this form possesses over the common type are that the V's on the casting being fitted will both be of the same width, and no difficulty is experienced in keeping the gage level, since it always lies in a horizontal plane by resting on the top of each V. At *A* and *B* are shown gages for the bed and carriage respectively; these gages are made of steel ¼ inch thick.

Assuming, for example, that the V-surface on the bed at *C* is tight to the gage, and a 0.002 inch feeler will just pass between the bed and gage at *D*, then 0.002 is the exact amount that must be planed off the surface *C*. When these two surfaces fit the gage so that no error can be detected with a 0.001 feeler, the gage is turned end for end, and the surfaces *E* and *F* are tested in the same manner. It is, of course, necessary to set the gage square with the bed and this is accomplished by trying the feelers on both sides of the gage. The same remarks apply to the carriage gage *B*. At *G* and *H* in the same engraving are shown gages in the form of cast iron blocks about 6 inches long which are used for testing the ways on bed and carriage as indicated; *I* is a sheet steel strip fastened to one end of gage *H* and this is used to test the apron seat *J*. All other measurements are tested with ordinary height blocks or caliper gages, as the case may require.

Referring now to the carriage, the sequence of operations in finish planing it is to plane the bearing for the shoe, and square up the ends, and then turn it over in the position shown in the engraving and plane the V's and other surfaces on this side. It is good practice to plane lathe carriages of this size in lots of six at a time by placing them in a "string" on the planer table. When completing the final operation, that of planing the V's, it is evident, however, that the carriages farthest away from the angle plate by which they are squared up, are particularly liable to error. With careful setting up, this error should not exceed 0.003 inch, which is easily and quickly scraped off by the assemblers.

Machining the Head- and Tail-stock

The methods of machining head- and tail-stocks vary greatly in different shops, and also with different sizes. Some makers first finish all the planing and then perform the boring operations and scrape in the head-stock spindle, while others leave a finishing cut to be taken on the bottom of the head- and tail-stock after the boring and scraping are completed, by setting up the castings on arbors held in V-blocks on the planer table. Both systems, or modifications of both, are frequently used in the same shop. While the first-mentioned system is the most economical in that it saves setting up the work on the planer twice, it is essential that the machining be such that very little scraping is required on the head-stock boxes; otherwise the head-stock will be thrown out of line in fitting the spindle, which necessitates replaning the head-stock and possibly the tail-stock.

In any event, it will always pay to leave 1/16-inch stock to be bored out of the bearing boxes, so that after the boxes are fitted in the head-stock it can be replaced in the boring jig and a finishing cut taken in the boxes, allowing 0.005 inch to be reamed out. Adjustable shell reamers are mounted on the boring-bar for this purpose. When this precaution is taken, and

* For additional information on this and kindred subjects, see "Assembling Machine Tool Units," in the October, 1909, issue of MACHINERY, and articles there referred to.

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the spindle is accurately ground to size, very little scraping should be necessary to make a good bearing. The object of leaving the 1/16-inch to be bored out with a cutter before reaming, is to insure that the reamer has an even cut and that sufficient stock is left for reaming.

Boring and Drilling the Bed

When all the planing is finished on the bed, it is next sent to the drilling department where the first operation consists in boring the shaft holes for the tumbler mechanism shown in Fig. 3. This operation is performed on a horizontal drilling and boring machine with the aid of a jig which also locates the sweep clamping bolt hole. The shafts *A* and *B* run in long cast-iron bushings that are a light drive fit in the bed, and to provide for standardization and enable the bush-

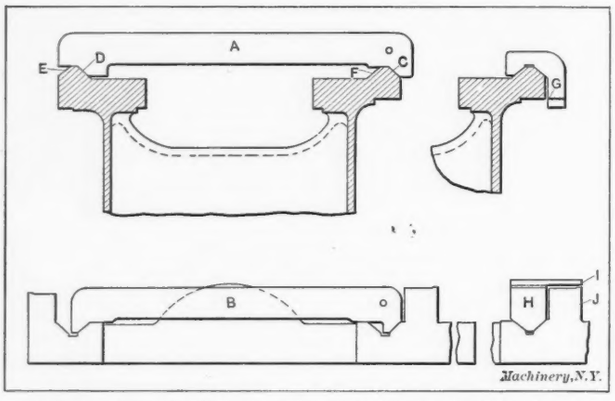


Fig. 2. Gages for Testing the Planing of Lathe Bed and Carriage

ings to be finished in large quantities, the holes in the bed are reamed to gage, adjustable shell reamers being mounted in the boring bar for this purpose. The hole for stud *C* is drilled and then finished with a rose reamer, after which it is hand reamed to gage. This hole and the sweep clamping bolt hole are the only ones that require facing, the method of taking the measurements being apparent from Fig. 4; *A* is a sheet-iron templet having an outline indicated by the heavy line; the opening at *B* locates the surface to which the stud boss is faced, while at *C* is shown whether there is sufficient clearance cored out for a feed gear. The templet is located sideways by the spline *D* which is riveted to the templet and

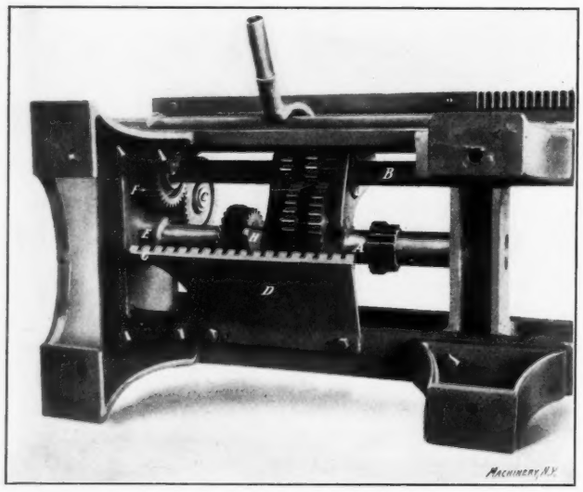


Fig. 3. Quick-change Gear Mechanism of Lathe shown in Fig. 1

fits the keyway in the bed; and endwise by being brought flush with the end of the bed. When in this position lines are scribed at *B* and *C*, after which the templet is removed and the hole counterbored to the line; *C* is chipped out later on if necessary.

To locate the surface *E* for the sweep clamping bolt hole, the gage *F* is used, its construction being clearly shown in Fig. 4. All lateral measurements on the bed are taken from the surface *B*. Facing surface *E* completes the operations for this setting, and the bed is then moved around for drilling and tapping the lead-screw box bolt holes.

In Fig. 5, *A* and *B* are jigs for drilling the front and rear lead-screw box seats, respectively. As will be seen, both jigs are located from the flat surface on top of the bed, the rear jig clearing the front V. Jig *A* is located endwise by seating against the hub *C*; the wooden pole *D* is used to set jig *B*. This pole has lines cut on one side, giving the settings for various lengths of beds up to 16 feet, so that the distance between the boxes, when bolted on, will be correct for the lead-screw. For longer beds, especially those in two sections, jig *B* is set from the rear end of the bed, and after the boxes are bolted on, the measurement is taken for the length to cut the lead-screw; it is not practicable to set the rear box or cut the lead-screw in the same way in this case as in the previous one, due to the error that is likely to occur in the length of the bed. This completes the work at the horizontal drill, and the bed is now moved to a radial drill, where the holes for the rack are next drilled. Special eccentric clamps are used for holding the rack in place, one of which is seen resting on top of the bed in Fig. 7. The advantages of this clamp over the common C-form are that it does not mar the work, no copper packing is needed, the clamping and loosening is quickly accomplished, and there is no danger of shifting the rack when clamping it.

When holes for the rack are all drilled, including the pin holes, the drill-hand taps and enters one screw in each rack section, so as to keep the rack in place after the clamps are removed, and until the bed reaches the assemblers. This avoids tying up the radial drill while the rack is being fastened on the bed, which is the practice in some shops.

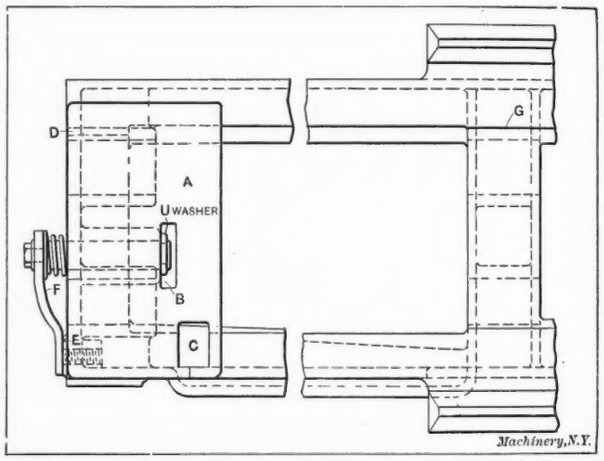


Fig. 4. Templet and Gage used when boring the Bed, shown in Position

On top of the bed in Fig. 7 are shown two fixtures *A* and *B*, respectively, which are used to locate the tumbler locking bar *D*, Fig. 3. Fixture *A* is also used to set the bushings *E* and *F*, Fig. 3, by inserting the stud in the fixture in place of the stud *C*, and bringing the bushings (which are straight) up against the hubs shown on the fixture. Now, with fixture *B* in position in the tumbler shaft hole, the locking bar is set so that its first notch *G*, Fig. 3, fits over the projection *C* of fixture *A*, Fig. 7. The plates *D* and *E* on fixture *B* are then moved so as to enter slots near the ends of the locking bar, after which the locking bar is set so that its slots bottom in the fixture plates. In this position the bar is marked off, and after drilling the two bolt holes, which have 1/16-inch clearance, it is again placed in position and clamped by its bolts. It is then shifted so as to bring it in the correct relation to the fixtures, and then the pin holes are drilled. With the bushings *E* and *F* (Fig. 3) located as previously mentioned, their set-screw holes are now drilled.

The legs are set and marked off on the bed with the aid of a wooden pole having lines scribed on it representing the center line of each inner leg. After these holes are drilled and tapped and the legs bolted on, the bed is next turned right side up for drilling the head-stock clamping bolt holes. The jig for drilling these holes is located on the bed by the keyway *D*, surface *G*, and hub *B*, Fig. 4, so that when the head-stock, which also was drilled by this jig, is bolted on, the feed gear on the spindle will line up with the intermediate feed

gear in the bed, and the head-stock casting will match the end of the bed. This completes the drilling, and the bed is next sent to the assemblers, where the actual work of assembling proper begins.

Scraping the Carriage and Assembling the Tumbler Mechanism

It is the general practice to keep the head-stocks, tail-stocks, carriages, tumbler members, etc., in stock, completely assembled, these units being identical for any length of bed. This method will be considered here, it being assumed that the units already have been brought to the assemblers. Two men usually are employed in assembling a lathe of this size, since a larger number cannot advantageously be used. Two men should be able to assemble such a lathe in 40 hours, total time. The operations of scraping on the carriage and assembling the tumbler mechanism are, of course, carried on simultaneously, one man working on each job; but for the purpose of description, each operation will be considered separately.

The preliminary operations on the bed consist of rough scraping the V's and inside bearing for the tailstock, fastening on the rack, and polishing the sides and top. When fastening on the rack, and polishing the sides, the bed is turned over for convenience of the workmen. The rack, which was temporarily fastened on by the drill-hand, is now removed and all the holes tapped, after which it is screwed fast, the pin holes reamed, and the pins driven in. A carpenter's brace is used for the taps and reamer. As the rack already has been polished on a disk grinder, it is only necessary to rub it with emery cloth to obtain a good finish. The bed is now turned right side up and carefully leveled, using iron wedges. During these preliminary operations the painting and any necessary chipping is done.

For scraping the carriage to fit the bed a special lifting device is used to facilitate turning the carriage over. This device was described by the author in the February issue of MACHINERY. When the carriage is being pulled along the bed for the purpose of finding the bearing, the lifter bolts are slackened off so as to prevent any danger of springing the carriage.

Fig. 6 clearly indicates the method of squaring the carriage with the bed. As will be seen, the sweep bar *A* is held in firm contact with the angle and bottom bearing of the carriage by means of two flat steel springs *B*, bent to the shape shown.

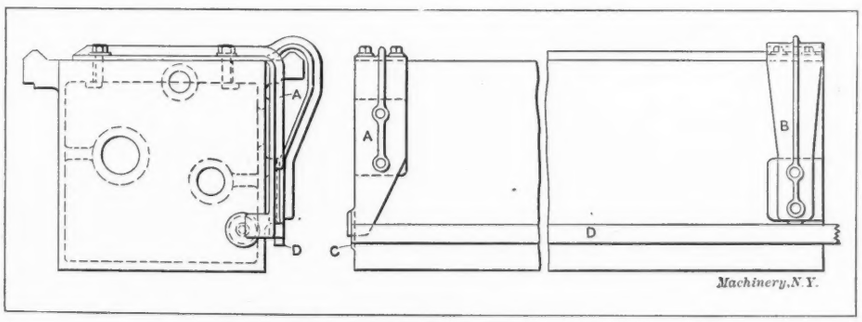


Fig. 5. Jigs used for Drilling Lead-screw Box Bolt Holes in the Bed

Brass shoes *C*, riveted to these springs, prevent the latter from cutting or scratching the bar. The function of coiled spring *D* is to hold the sweep bar collar *E* in close contact with the end of the carriage. With this device, the sweep is easily and quickly applied or removed, more precise measurements are obtained than by having an operator hold it, as is the usual practice; and besides, only one man is required to perform the operation of testing. In operation, micrometer point *F* is set to one position as shown, using a piece of cigarette paper as a "feeler"; then the sweep is rotated to the opposite side and a measurement taken as before. The carriage is scraped so as to turn the face-plate about 0.001 inch concave.

Very little scraping is necessary on the bed, merely enough to smooth the V's and break up the bearing, the tool marks being visible after the scraping is completed. When this work is accomplished, the carriage gibs are fitted, the apron is bolted in place, and the cross-feed screw, shoe, etc., are placed in position. Next, the tail-stock cricket is placed on the bed and its packing fitted, after which it is pulled the entire length of the bed to determine if the latter is straight. After any high spots on the bed are scraped off, the tail-stock traverse bracket is bolted onto the cricket, and then the tail-stock and its shoes are placed in position.

Referring again to Fig. 3, the tumbler mechanism is assembled in the bed as shown in the illustration, the operation being so simple that no explanation is necessary. Holes in the bed for the oil pipes (not shown) are drilled by means of a pneumatic drill, this being done, of course, preceding the assembling operation. The slot in the interlocking plate *H* is now marked off, the plate removed, and the slot cut. The position of this slot is determined by having the tumbler gears in a central position between the largest change gears. With the interlocking plate again screwed onto the tumbler, the thirty-four holes in the bed for the tumbler locking pin are now ready to be drilled.

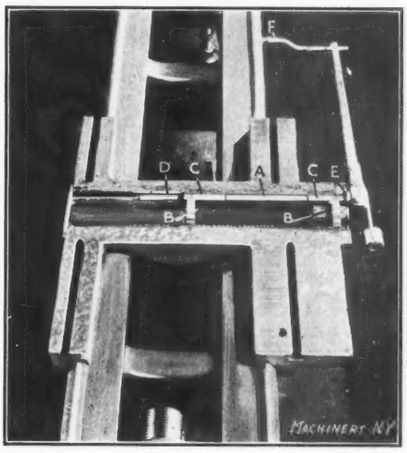


Fig. 6. Top View of Carriage, showing Method of Squaring the Carriage with the Bed. Springs B and D hold the Sweep in Position, enabling One Man to make the Test

Drilling these holes is the most interesting operation on this part of the lathe, the manner of accomplishing it being immediately apparent from Fig. 8, which shows the tools used, some of them being seen on top of the bed. The method of holding the tumbler in engagement with the various change gears while drilling the holes in the bed is clearly shown in Fig. 9. Paper, to the thickness of about 0.005 inch, is placed between the teeth of the engaging gears before they are brought into mesh, and when the jack screw *A* is tightened sufficiently to hold the tumbler rigidly in place, the gears are in proper mesh. The holes are first drilled with a special drill that fits the locking pin hole in the tumbler and has flutes milled only a short distance up from the point, so as to avoid cutting the hole in the tumbler. Fig. 8 shows this drill in position in the air drill. For finishing the holes, a special rose reamer, shown at *B*, is used in the same manner.

The tools are fed into the work by means of the bar *C*, which is pointed on one end so that it can be driven into the floor to prevent slipping. The operator presses his shoulder against the upper end of the bar, holds the throttle of the air drill with the left hand and pulls on the bed with the right hand. Each hole is drilled in succession, alternating between the top and bottom rows. The record for drilling and reaming these thirty-four holes, including the time required to set the tumbler, is 50 minutes. In setting the tumbler for drilling, its lateral movement for the various positions is controlled by the interlocking plate engaging the respective slots in the locking bar. (See Fig. 9.)

To mark off the groove which is seen between the two rows of holes in Fig. 1, a special scriber is used that fits the tumbler locking-pin hole, the tumbler being held in a neutral position by the locking bar. Two circles are scribed, one at each end of the groove to be cut, and then a straightedge is used in scribing lines connecting the two, the lines acting as a guide when chipping the groove with an air hammer. Inserting the handle, chipping the groove, and fastening on the number and index plates completes the operation on the tumbler mechanism.

Lining up the Head-stock and Tail-stock

The bed is now ready to receive the head-stock and while this is being fitted on by one of the assemblers, the other is working on the lead-screw, lead-screw boxes, and change gear sweep. As the head- and tail-stock were tested for alignment before being sent to the store-room, it is now only necessary to line up the head-stock on the bed and fit the taper dowel pins.

The method of testing these parts is interesting, inasmuch as the test arbor used is somewhat out of the ordinary. A jig is used that represents the head-end section of a 24-inch lathe bed. The jig and whole outfit of fixtures used, together with a head- and tail-stock in position for testing, is shown in Fig. 10. As will be seen, the test bar is square at *A*, near each end, the object being to use the indicator on a flat surface when testing the spindle for parallelism with the V's, and on a cylindrical surface when testing the spindle taper hole for concentricity. The two squares are integral with a sleeve that can be turned independently of the bar, and in this way one plane surface can be set at a mean between the "high" and "low" point on the bar. This adjustment is obviously necessary, since the bar is particularly liable to run out at its free end, due to a number of conflicting elements, the error in any one of which may be infinitesimal. When using the plane surfaces, one of these is always trued up with the square *B*, as shown in the engraving.

The reason for providing a plane surface on which to indicate is this: Suppose, for example, that we are testing the spindle for alignment sideways, and further that the axis of the spindle actually is parallel sideways with the bed, but

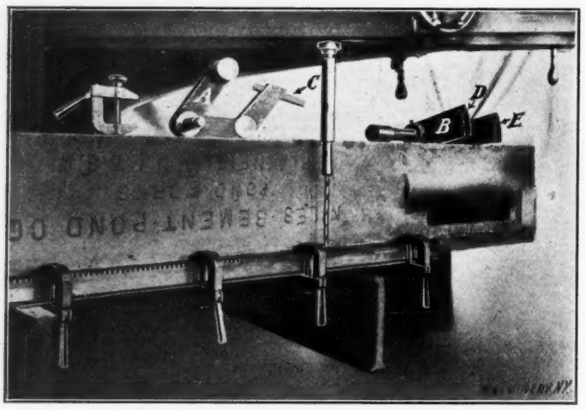


Fig. 7. Special Clamps for Holding Rack in Position when Drilling, and Fixtures used for Locating Tumbler Locking Plate

that the axis does not lie in a horizontal plane, it being high on the front end, say 0.005 inch in the length of the test bar. Then in indicating on the older type of bar with cylindrical collars, the line of motion of the indicator point in traveling from one collar to the other is not parallel with the axis of the test bar and therefore the readings are false. Now, with the form of bar having plane surfaces, assuming the conditions to be the same as regards the alignment of the spindle, the reading will show that the alignment is perfect sideways, because the indicator point is moving on a plane surface.

Referring again to Fig. 10, the fixture *C* is guided on the V tracks of the bed and is constructed so that it is adjustable for holding a Starret indicator *D* either on the side or top of the bar as the case may require. Having explained the use of the tools and fixtures, the method of "lining up" the head-stock and tail-stock, both with reference to the V's and to each other, is to place them on the bed and approximately set the head-stock true sideways by inserting keys in the keyways planed in the head-stock and bed for this purpose.

With the clamping bolts tightened lightly (the bolts have 1/16-inch clearance), the head-stock spindle taper hole is first tested for concentricity by indicating on the cylindrical surface *E* while slowly rotating the spindle. Then with the squares *A* set as previously explained, the head-stock is moved around by knocking it with a babbitt hammer until the reading on both surfaces is the same. The bar is then moved over into the tail-stock spindle hole, and after the set-over screw *F* is adjusted so as to bring this spindle in line with that in the head-stock (the reading being the same as before) the tail-stock spindle is tested for alignment sideways. Now the indicator is set on top of the bar, with the latter turned so as to use the same surface, and then the tail-stock spindle is tested for alignment in a horizontal plane, after which the bar is again set into the head-stock spindle hole and that spindle tested both with reference to the V's and to the tail-stock spindle. It is understood, of course, that if any errors are discovered which exceed the allowable limits of variation, the part at fault is either filed and scraped to bring it true, or machined, if the circumstances warrant.

Turning again to the lathe bed, we will assume that the head-stock is lined up as just described, and the clamping

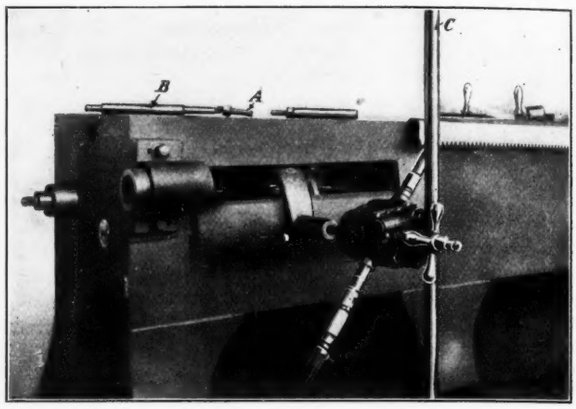


Fig. 8. Method of Drilling and Reaming the Holes in the Lathe Bed for the Tumbler Locking Pins

bolts are tightened down hard. The taper dowel pin holes are then drilled, reamed, and the pins driven in, care being exercised to see that the pins are a good fit. Next the face-plate is screwed on, ready to be turned off.

Lining up the Lead-screw Boxes

As was previously stated, work has been progressing on the lead-screw boxes and other minor details. For the purpose of lining up the boxes and also to test the alignment of the lead-screw bearings in the apron, a short arbor is used that represents the lead-screw. First the apron is tested, and then the lead-screw boxes are bolted onto the bed and lined up with the apron. Sometimes it is necessary to file the apron seats or adjust the boxes to bring them into proper alignment; but with careful planing and thorough inspection of the parts, this should not be required. Two special gages are used to

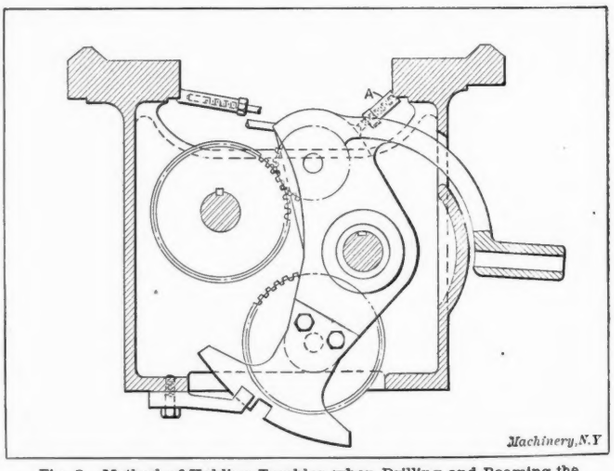


Fig. 9. Method of Holding Tumbler when Drilling and Reaming the Locking Pin Holes by the Method shown in Fig. 8

facilitate the aligning; one gage reaches down from the flat track on top of the bed for horizontal measurements, while another is held against the side of the bed just below the V to test sideways. Both gages are provided with micrometer points to enable the accurate measurement of error.

Referring to Fig. 1, the head-end lead-screw box is set longitudinally when the change gear sweep is in place, so as to line the box with reference to the sweep bearing on the end of the bed. When properly set, the boxes are drilled and reamed for the taper dowel pins; then the lead-screw is put

in place, its checknuts screwed on, and the gears on the sweep brought into proper mesh.

The Finishing Operations and Inspection

With the cone belted up to a countershaft or other source of power, the bearings are thoroughly oiled, and the lathe is run idle for a while preparatory to turning off the faceplate. The V's on the bed and bearings on top of the carriage are now spotted with a scraper, while all other finished surfaces receive their final polishing. The centers and their respective holes in the spindles were fitted to male and female gages during the machining process, so that now it is only necessary to place the centers in position. Clamping on the center-rest is the final assembling operation.

All machines are more or less defective, as it is practically impossible to make anything absolutely perfect. Knowing this, the builder establishes a limit within which the error will not materially affect the working of the machine, and furnishes the inspector with a list of allowable limits.

The inspection is carried on as the work proceeds, so that no part is neglected, and no defective material or faulty workmanship is allowed to pass. Gearing of all kinds is inspected and tested for alignment and smoothness of operation. The fits of all wearing surfaces are tested, as well as the fit of the various screws and binding and clamping fixtures. All information obtained from the inspection is entered on a printed form. Each machine is given a serial number, and the reports are filed in the office, so that in case of any trouble arising or any repairs being required for a given lathe, an exact record of its condition when it left the shop is available.

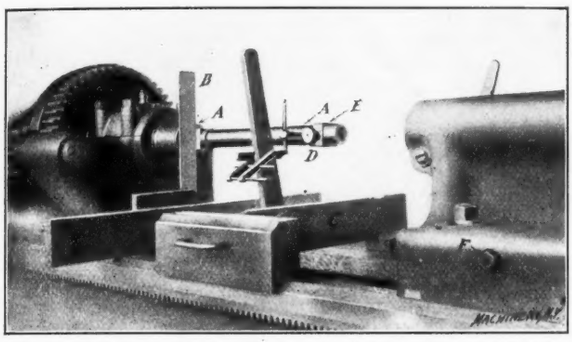


Fig. 10. Special Form of Test Bar for Aligning Head- and Tail-stock. Plane Surfaces are used for Testing Parallelism, and Cylindrical Surfaces for Testing Concentricity

After truing up the face-plate, it is tested by means of a straight-edge and cigarette paper, this kind of paper being the best for the purpose. The spindle is tested for end motion when running, by application of the Starrett indicator to the face of the spindle nose. To prove the alignment of the head spindle with the shears of the lathe and the alignment of the taper hole with the spindle, under actual working conditions, a steel test bar is provided which fits the taper hole and projects 18 inches from the spindle. This bar carries three cast-iron collars, placed one at each end and one in the middle, from which all measurements are taken. A light cut is taken across these collars with a keen diamond-point tool, and the collars are then measured with a micrometer. As it is desirable when boring a hole, to have the taper, if any, large toward the front end, the front end of the head-stock was purposely set slightly toward the rear of the bed so that the outer collar should be found 0.0005 inch larger than the collar next the spindle. The alignment of the spindle in the vertical plane is again tested by attaching the indicator to the tool-post and traversing the carriage along its ways with the contact point of the indicator pressing against the top surface of the collars.

In testing the alignment of the taper hole with the spindle itself, after the collars have been turned off, the test bar is removed, turned half way round and replaced in the spindle; the indicator is then put in the tool-post in place of the turning tool, and with the contact point on the center line the indicator is traversed past the collars, the variation in readings showing twice the error in the alignment of the taper. The alignment of the tail-stock spindle is now tested, the method being the same as in the previous instance.

APPROXIMATE HORSE-POWER FORMULAS FOR GASOLINE ENGINES

In the September 3, 1909, issue of *Industritidningen Norden*, Mr. E. Hubendick reviews the various approximate formulas which have been adopted or proposed by a number of societies and individuals for the horse-power of gasoline engines. In these formulas

D = diameter of cylinder,
N = number of cylinders,
S = length of stroke,
n = number of revolutions per minute.

The French Automobile Club's formula is:

H. P. $= 0.07\ D^2N$, when the diameter is given in centimeters,
H. P. $= 0.45\ D^2N$, when the diameter is given in inches.

In this formula the mean pressure has been assumed to be 5.3 kilograms per square centimeter (75 pounds per square inch), and the piston speed 5 meters (16 feet 5 inches) per second.

The Royal Automobile Club's (British) formula is:

H. P. $= 0.0625\ D^2N$, when the diameter is in centimeters.
H. P. $= 0.405\ D^2N$, when the diameter is given in inches.

Mr. Arnon's formula is:

H. P. $= 0.0061\ D^2N$, when the diameter is in centimeters.
H. P. $= 0.1\ D^2N$, when the diameter is given in inches.

Mr. Faroux's formula is:

H. P. $= 0.0074\ D^{2.4}\ S^{0.6}$, when the diameter is in centimeters.
H. P. $= 0.121\ D^{2.4}\ S^{0.6}$, when the diameter is given in inches.

Another French formula is as follows:

H. P. $= 0.02562\ D^{2.4}\ N$, when the diameter is in centimeters,
H. P. $= 0.24\ D^{2.4}\ N$, when the diameter is given in inches.

Mr. T. Thornycroft's formula is:

H. P. $= \dfrac{D^2\ S^{0.75}\ N}{35{,}000}$, when the diameter is given in centimeters,

H. P. $= \dfrac{D^2\ S^{0.75}\ N}{2{,}700}$, when the diameter is given in inches.

Prof. H. L. Callender's formula is:

H. P. $= 0.0875D\ (D - 2.5)\ N$, when the diameter is given in centimeters,
H. P. $= 0.565D\ (D - 1)\ N$, when the diameter is given in inches.

In this latter formula the mean pressure is assumed to vary in the same proportion as $\left(1 - \dfrac{2.5}{D}\right)$ if the diameter is given in centimeters, and $\left(1 - \dfrac{1}{D}\right)$ if the diameter is given in inches.

The Royal Automobile Club's (Swedish) formula is:

H. P. $= \dfrac{D^2SnN}{250{,}000}$, when the diameter is given in centimeters,

H. P. $= \dfrac{D^2SnN}{15{,}240}$, when the diameter is given in inches.

In this connection the formula of the Association of Licensed Automobile Manufacturers, which has previously been published in MACHINERY, should be included:

H. P. $= \dfrac{D^2N}{2.5}$, when the diameter is given in inches.

H. P. $= 0.062\ D^2N$, when the diameter is given in centimeters.

The horse-power of automobile engines, based on this last formula, for various diameters of cylinders, was tabulated in the Data Sheet Supplement accompanying the October, 1909, issue of MACHINERY.

Some of the formulas proposed, with fractional exponents, are more cumbersome to use than would be the exact horse-power formula, and are of very doubtful value for their purpose. It is difficult to understand why one should be given an approximate formula at all, unless the form of that formula be such that it greatly facilitates computations, as compared with the exact formula. In this respect the A. L. A. M. formula is one of the best of those given above.

NORWEGIAN LATHE OF MODERN DESIGN*†

The accompanying half-tone, Fig. 1, illustrates a 20-inch engine lathe embodying some new and interesting features, including a special all-gear head-stock, which has recently been brought out by Brödrene Sundt, Christiania, Norway, one of the most prominent of the Norwegian machine tool building firms.

The special feature of this lathe is the interesting and original design of the gearing in the head-stock. As will be seen from the half-tone illustration, the machine is of the single-pulley all-gear head type; a section through the head, indicating the arrangement of the gearing, is shown in the line engraving in Fig. 2. Through an interesting arrangement of the driving mechanism, the number of gears and shafts in the head-stock is reduced to a minimum, so that only nine gears in all are used to obtain eight different speeds.

Referring to Fig. 2, the gear *A* runs loose on the spindle *K*, while gear *B* is keyed to the spindle and is capable of sliding back and forth, so that it may be either in engagement with gear *C* on the intermediate shaft *L*, or engaged by clutch teeth on its end with similar clutch teeth on gear *A*. Gear *C* is keyed to the intermediate shaft *L* and gear *D* is made in one piece with this shaft. Gear *E* on shaft *M* meshes with gear *C*. It is keyed to its shaft, and is capable of sliding out of engagement with *C*. The rawhide gear *F*, also keyed to shaft *M*, meshes with gear *G*, which runs loose on a bushing on the main driving shaft *N*. Finally, gear *H* is also keyed to shaft *M* and meshes with gear *I* on the main driving shaft. This latter gear is keyed to its shaft, but is capable of sliding so that it may either mesh with gear *H*, or be brought into engagement by means of the clutch teeth on its end with corresponding clutch teeth on gear *G*.

The different speeds are obtained by the operation of the three handles or clutch levers shown in Fig. 1, two in the front of the head-stock and one on the top. One of the handles, which provides the sliding motion for gear *E*, as indicated in Fig. 2, operates also, simultaneously, by means of the rack *P*, the sleeve *O* keyed to shaft *L*, on the end of which clutch teeth are provided, meshing with similar teeth on the projecting hub of gear *G*. Another of the levers operates gear *I*, and the third lever gear *B*.

The eight spindle speeds are obtainable by the following gear combinations:

1st speed—Through gears *I*, *H*, *E*, *C*, *D* and *A*.
2nd speed—Through gears *G*, *F*, *E*, *C*, *D* and *A*.
3rd speed—Through gears *I*, *H*, *F*, *G*, *D* and *A*.
4th speed—Through gears *D* and *A* directly.
5th speed—Through gears *I*, *H*, *E*, *C* and *B*.
6th speed—Through gears *G*, *F*, *E*, *C* and *B*.
7th speed—Through gears *I*, *H*, *F*, *G*, *C* and *B*.
8th speed—Through gears *C* and *B* directly.

These speeds are doubled by means of a two-speed countershaft running, respectively, at 200 and 260 revolutions per minute. The sixteen spindle speeds thus obtainable by means of the head gearing and the two-speed countershaft are as follows: 9, 12, 15.5, 20, 24, 30, 38, 50, 55, 70, 90, 115, 135, 175, 225 and 290 revolutions per minute.

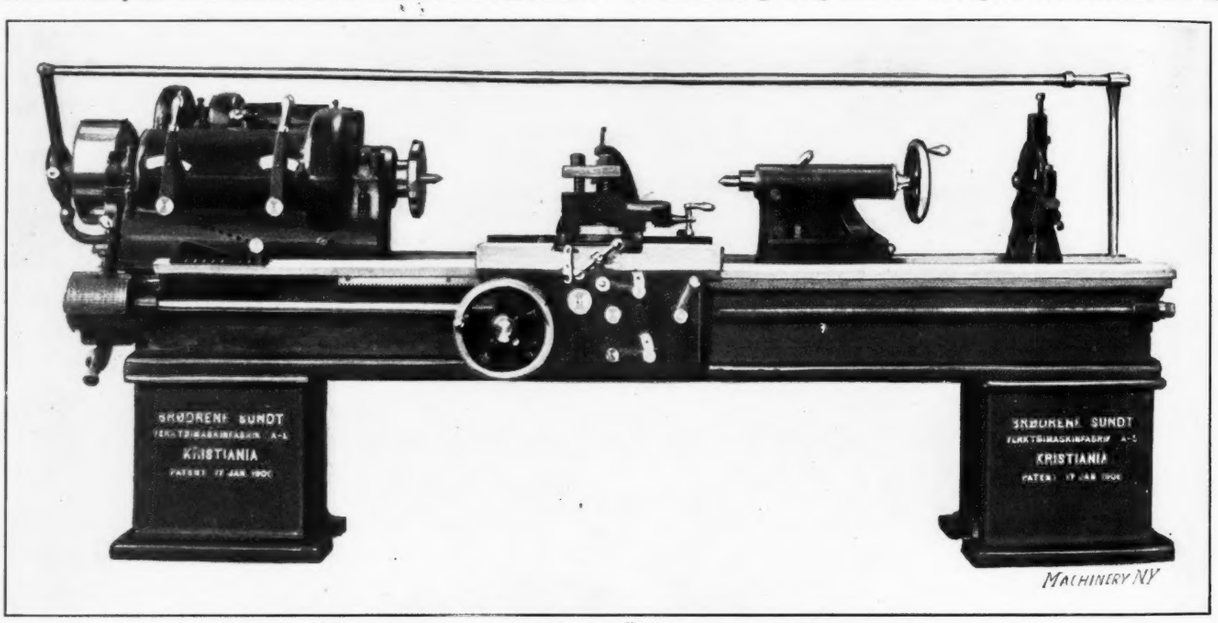


Fig. 1. Twenty-inch Lathe built by Brodrene Sundt, Christiania, Norway

There is no clearance between the clutch teeth on the various gears. They are milled with an angle of 7 degrees on the sides and can be thrown in mesh without difficulty, under any conditions. When gear *B* occupies its medium or neutral position the spindle can easily be rotated by hand. The driving pulley is provided with a special friction which can be instantly released by operating the friction clutch lever con-

* The following articles dealing with machine tools of European design have previously been published in MACHINERY: Some Notes From an English Shop, September, 1897; English Amateur Tools (Foot Power Milling Machine), June, 1902; Heavy German Milling Machine, June, 1903; Koehler's Profile Lathe, June, 1904; A Large Vertical Planer, June, 1904; Some English Lathes, September, 1904; German Lathe Carriage for Screw Cutting, October, 1904; The De Fries Precision Lathe, November, 1904; An English High-Speed Planer, July, 1905; A Pendulating Electric Drill, September, 1905; Portable Tools From Europe, November, 1906; A Vertical Miller and a Turret Lathe of English Design, March, 1907; Recent Development of British Machine Tool Industry, July, 1907; Some British Machine Tools, November, 1907; Notes From the Olympia Exhibition, December, 1907; Advanced Designs of German Drilling Machines, June, 1908; A Large Planer of English Design, August, 1908; Modern German Milling Machines, August, 1908; Large Horizontal Boring and Turning Mill, August, 1908; British Machine Tools at the Franco-British Exhibition, September, 1908, engineering edition; Herbert Automatic Turret Lathe, with Self-Selecting Feeds, November, 1908; Germaan Design of Vertical Spindle Presses, December, 1908; German Designs of Internal Grinding Machines, January, 1909; Societe Francaise de Machines-Outils Single-Pulley-Drive Lathe, March, 1909, engineering edition; Modern Swedish Machine Tools, March, 1909, engineering edition. See also, for descriptions of European gear cutting machines, a series of articles entitled Gear Cutting Machinery, January to September, 1908, and Recent Developments in Gear Cutting Machinery, February, 1909.

† The following articles describing lathes with geared heads have previously been published in MACHINERY: A New "American" Motor-driven Lathe, December, 1902; A New Motor-driven Lathe, March, 1903; The "Ideal" Engine Lathe with Motor Drive, January, 1904; New Flat Turret Lathe, May, 1904; Sixty-inch Roll Turning Lathe, October, 1904; Thirty-inch American Engine Lathe, October, 1904; Lodge & Shipley Lathe with Motor, November, 1904; American Twenty-two-inch Lathe, December, 1904; Motor-driven Lathe with Geared Head, June, 1905; The Draper Geared Head Lathe, July, 1905; Rapid Reduction Lathe, Nineteen-inch Capacity, July, 1905; Hendey-Norton Lathes, April, 1906; Pratt & Whitney Sixteen-inch Toolmakers' Lathe, March, 1907; New Design of the Lo-swing Lathe, September, 1907; The Full Swing Side Carriage Turret Lathe, December, 1907; Notes from the Olympia Exhibition, December, 1907; Motor Drive Mechanisms for the Le Blond Lathes and Milling Machines, February, 1908; Bridgeford Geared Head Lathe, March, 1908; Libby Turret Lathe, March, 1908; Springfield Motor-driven Brass Finishers' Lathe, April, 1908; Bridgeford Thirty-six-inch Geared Head Lathe, May, 1908; Hendey Single-pulley and Motor-driven Geared Head Lathes, May, 1908; Schellenbach Sixteen-inch Geared Head Lathe, June, 1908; Rahn-Carpenter Sixteen-inch Motor-driven Lathe, June, 1908; Springfield High-power Motor-driven Lathe, July, 1908; British Machine Tools at the Franco-British Exhibition, September, 1908; Lodge & Shipley Heavy Axle Lathe, January, 1909; Prentice Brothers' Sixteen-inch Shaft Turning Lathe, January, 1909; Whitcomb-Blaisdell Single-Speed-Pulley Gear-driven Lathe, January, 1909; Societe Francaise de Machine-Outils Single-Pulley-Drive Lathe, March, 1909; Modern Swedish Machine Tools, March, 1909; Lodge & Shipley Crank-Shaft Lathe, June, 1909; Lodge & Shipley Lathe With Automatic Feed Stops, July, 1909; The Lodge & Shipley "Marvel" Lathe, August, 1909; Bradford Sixteen-inch Motor-driven Engine Lathe, October, 1909; Bridgeford Bevel Gear Turning Lathe, October, 1909.

nected with the rod passing the full length of the machine, as shown in Fig. 1.

The construction of the friction drive in the pulley is briefly as follows: The friction ring *R*, Fig. 2, is made in halves enclosing the spindle driver *S*. Both halves of the ring can be made to grip the spindle driver *S* by means of the tighteners *T*, operated by the fingers *U*. Only one set of these is shown. Two helical springs hold the rings away from the driver *S* as soon as the friction is released.

The clutches in the geared head are so arranged that two different speeds can never be applied simultaneously, and therefore there is no danger of breakage to the gears due to the carelessness or ignorance of the operator. All the speeds can be changed without stopping the belt or motor.

The bed of the lathe, as seen in Fig. 1, is of deep box construction, and is ribbed on the inside at short intervals with strong cross ribs. The spindle is forged of Bessemer steel and runs in journals of phosphor bronze. As shown in Fig. 2, there is a hole clear through the spindle. The end pressure is taken up by hardened steel and phosphor-bronze washers, cased in so as to be perfectly dust-proof. All the bearings are

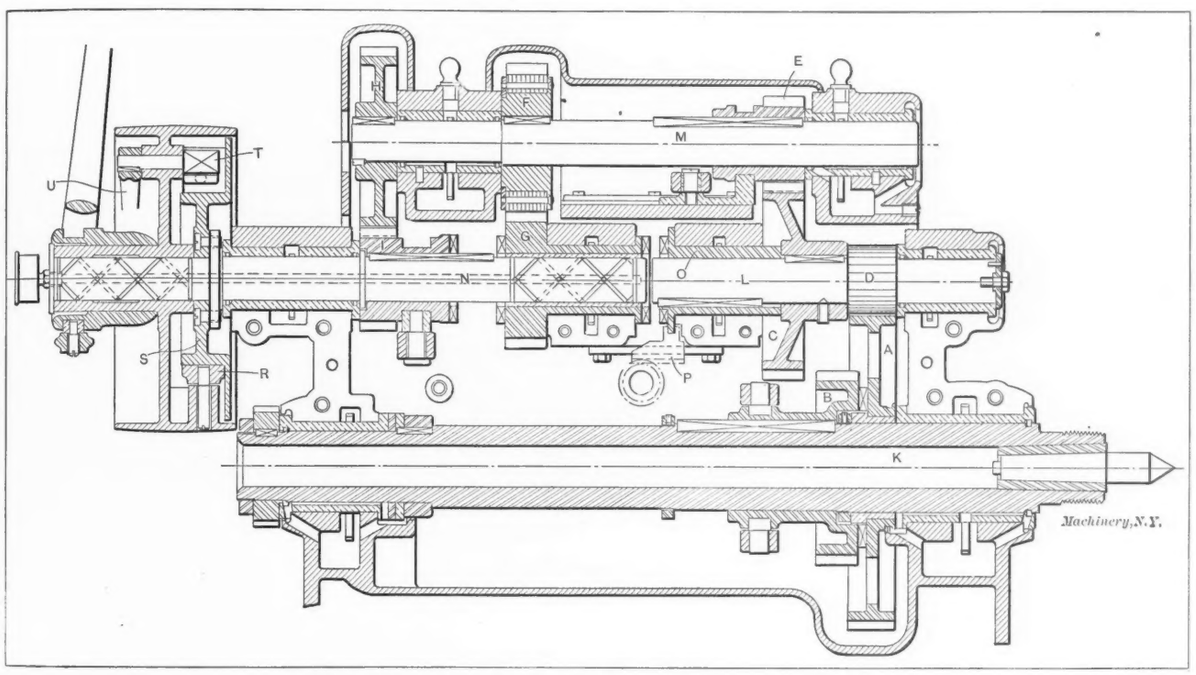


Fig. 2. Section of Head-stock, showing Geared Drive of Norwegian Lathe

provided with automatic lubrication, and as the spindle is free from belt pull, the accuracy of the work done on the lathe is not affected by this influence.

The screw cutting and feed arrangement is through a feed gear box operated by two handles. Thirty-seven different pitches can be obtained for thread cutting without changing any gears or stopping the machine. The carriage is of heavy construction; the gears in the apron are cut and of steel, the same as all the gears in the head-stock. The studs for the gears are hardened and ground on the bearing ends. There is no separate feed rod, the lead-screw being splined, and the half-nuts disengaged when the lathe is not used for thread cutting, the rack-feed being used for ordinary feed of the carriage. Provision is made for preventing simultaneous engagement of the lead-screw and rack-feed, and the feeds are reversed directly from the apron. As will be seen in Fig. 1, all gears are properly protected by guards.

The general dimensions of the lathe are as follows: The swing over the bed is 20 inches, and the swing over the carriage 13¾ inches. The length of the bed is 10 feet, and the maximum distance between the centers, 5 feet 6 inches. The hole through the spindle is 1¾ inch in diameter. The machine can be either belt-driven from a countershaft, or provided with direct motor drive. A five horse-power motor is required. The approximate weight of the machine is 5,100 pounds. A 22-inch size of the same design is also made by the builders.

THE CREATION OF MACHINISTS*

Referring to the title of the paper, namely, "The Creation of Machinists," I will merely mention the matter of apprentices, because the subject of this paper is more to show how to create machinists without passing through an apprenticeship, because of the extreme shortage of machinists throughout the whole United States.

A few years back we found that we were unable to obtain boys as apprentices, for the reason that they could get better pay in other trades, such as shoe factories, tobacco factories, tanneries, dry goods and other stores, and this caused us to raise the hourly rate, which was originally 5 cents, to 8 cents. But at that time we were allowed to use boys between the ages of 14 and 16 years. Since then a law has been passed in Ohio prohibiting boys working more than eight hours when under 16 years of age; and in order to comply with this law, we discharged all boys who were under 16 years. We then found, speaking for our own company, that in order to get a sufficient supply, the rate must again be raised from 8 cents to 9 cents per hour.

Simultaneously with this difficulty of obtaining boys, came the great activity among the builders of automobiles. This occurred during the time that business was very dull in the machine tool line. When business became active once more, having the addresses of all of the machinists who were formerly employed by us, we sent to each one a letter, stating that they could return to work, and we were surprised to receive almost no responses; and we then saw that we would be obliged to go into the creation of machinists on rather a large scale. Advertising in the daily papers and in the *American Machinist* brought comparatively no results. We then decided to re-arrange our work and divide it into very much smaller items than heretofore, arranging the parts so that they could be machined with the greatest possible simplicity, and then set about inquiring for men, not machinists, and the following advertisement was put in the daily papers:

WANTED—Young men between the ages of 20 and 30 years. Fair wages and good opportunities for advancement. Men accustomed to safe making or carriage making preferred.

The first day following this advertisement we obtained twelve out of possibly thirty applicants. They were selected largely because of their former experience, and somewhat upon their personality, personal appearance and address. These twelve men were placed, one in each of twelve departments, with instructions to the foremen as to the pieces they

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

should be taught how to produce. We found that by this method the first installment of twelve were readily assimilated, so that within one month we were ready for similar installment.

Now I will give you an idea as to how we proceeded in the matter: We arranged with a first-class machinist who has been with us a long time, in whom we have a great deal of confidence, and who possesses the art of knowing how to teach, to go from one man to another, see how he was performing his part of the work, set him right when he was wrong, and give him further explanations when an additional piece was added to the work he had already been taught. All of this involved the installment of some new tools, and in the beginning a slower production; but as these young men became better acquainted with the work, we advanced them from 15 cents to 17½ cents per hour, and some of them to 20 cents per hour, and it now appears that quite a number of them within a very short time may be advanced to 22½ cents, from that to 25 cents, and so on. As this advance takes place, they will, of course, have been taught how to do additional pieces.

All of this taxes the patience of the foremen quite considerably, and results of course in more spoiled pieces of work, but the final result of obtaining a sufficient number of men to run the establishment is brought about. There is the further advantage that men with the limited knowledge that these men must necessarily have, do not have the confidence to change into other shops so readily as the regular machinist.

There is another reason why machinists are so scarce, and that is the many fields to which they are called, and which fields do not make machinists. Let anyone call to mind how many machinists are now employed in hotels and large office buildings for running the elevators and electric light plants; how many are now taken for street railroads; besides all those who are taken into the office and drawing rooms or who are sent out on the road. Every consumer of machinists should be a producer; in the trades mentioned they are not producers, and consequently it is advisable for every machine shop, regardless of business conditions, to start more beginners than they need. The shop itself will require an increased number when the beginners graduate; some will drop out, some will be dropped, and others will be enticed into new enterprises which must have machinists ready-made. Beginners once obtained should be encouraged at every step. They should be given as little disagreeable work to do as practicable. They should be given the best work that they are capable of doing. They should be made machinists at once if their capabilities permit of it. A vacancy for even one hour in a higher place should be filled for that hour by one from a lower place. All the employes should be given all the encouragement possible that would take them into night schools, trade schools and correspondence schools. Wherever there is a serious shortage the men in your employment should be asked to invite any of their acquaintances to make application for employment in the machine shop.

To carry out the above recommendations it is necessary to make the machine shop something of a school. It is not likely that young men with a very limited knowledge of the machine making business will know just where the points of excellence are wanted, and in order to place the matter before them permanently, rather than to depend upon their foreman telling them, certain instructions, which are issued in any event to the inspectors, should be issued to each and every one of the men in the establishment, or if not, then at least they should be hung in such a position that each and every man and boy may read them.

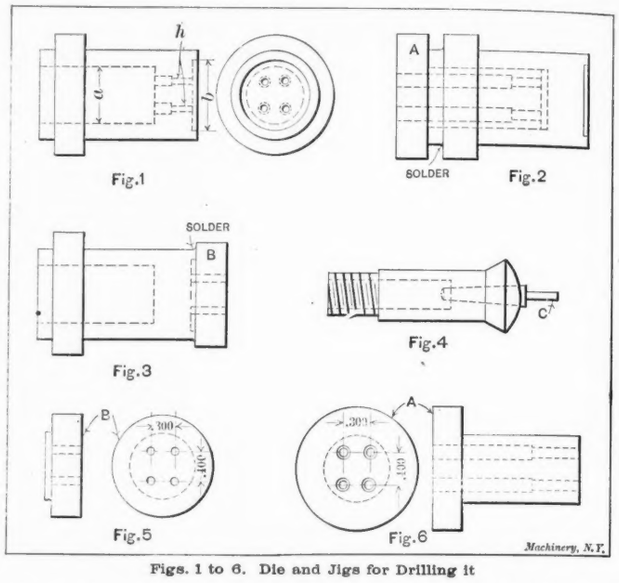
Very strict orders should be given to all foremen and superintendents to make every endeavor to retain any man who wants to leave, or anyone they are inclined to discharge. This is of the utmost importance, as otherwise it keeps a regular stream of men coming into the place and leaving it. One of the manufacturers in Detroit told me a few days ago that he was obliged to discharge and take on seven hundred and fifty men every month. It is not to be expected that we can create machinists in a short space of time without giving the method of doing it a great deal of care, and unless the man is a drunkard, or has an exceedingly bad disposition, good treatment and a sufficient amount of tact and patience will retain a great many who are otherwise discharged.

MACHINE SHOP PRACTICE*

JIG AND DIE WORK IN THE BENCH LATHE—1

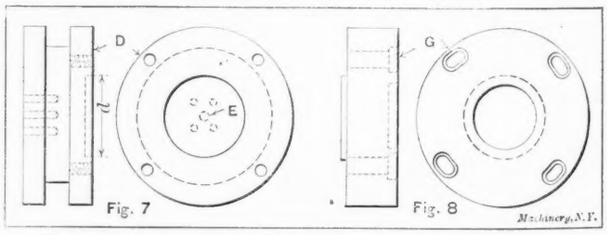
A. L. MONRAD†

In the manufacture of fine machinery, and for the finer work of the tool-room, the bench lathe is found invaluable, as the ordinary engine lathe is too large and unwieldy for this class of work. As the bench lathe is used exclusively for light precision work, it is made with great accuracy, and it is usually equipped with milling, grinding, screw-cutting and other attachments which make it suitable for a wide range of work. As an example of the kind of work for which



Figs. 1 to 6. Die and Jigs for Drilling it

the bench lathe is adapted, we have selected and will describe in detail the way in which two small jigs are made, which are to be used for drilling the holes *h* in the die shown in Fig. 1. As the inner half of each of these holes is enlarged, the drilling is done from each side of the die, the jigs *A* and *B* being inserted as shown in Figs. 2 and 3, respectively. Jig *A* is used for the larger holes, and *B* for the smaller ones. These jigs, which are shown in detail in Figs. 5 and 6, are made of brass. While they are being turned, they are held in a universal chuck screwed on the bench lathe spindle. The shoulder on jig *B* is fitted accurately to the recess *b* in the die, and the body of jig *A* is also turned to a close fit for the hole *a*. In order to bore the holes in each of these jigs in exactly the same relative positions, a steel master-plate *D*



Figs. 7 and 8. Master Plate and Attached Piece used in drilling Holes in Jigs, Figs. 5 and 6

(Fig. 7) is first made, the use of which will be explained presently. This plate should be first turned in an engine lathe; it is then strapped to the face-plate *F* of the bench lathe (Fig. 9), and both sides are faced so that they are exactly parallel. The outside of the master-plate should be set perfectly true by the use of a test indicator, after which a central hole *E* is bored and reamed to fit a plug gage 0.050 inch in diameter. The master-plate is then removed, and the four outer holes shown in the end view are laid out from the center hole to the dimensions given in Figs. 5 and 6. The centers of these holes are next drilled and tapped for 1/32-inch screws, which are to be used for holding indicator buttons in place. These buttons are small cylindrical pieces which are

* With Shop Operation Sheet Supplement.

† Address: 58 Connecticut Boulevard, East Hartford, Conn.

used by tool-makers for accurately locating work. Four of the buttons are fastened to the plate with small screws, and then by working from a plug in the central hole, the buttons are shifted until their center distances exactly coincide to those given in Figs. 5 and 6. When the buttons are accurately set, the master-plate is again strapped to the face-plate, and a test indicator is used to set one of the buttons perfectly true. This one is then removed so that a hole may be bored and reamed. In the same way the other three holes are bored and reamed, and the size of each is made to coincide with that of the central hole *E*. It will be seen that if the buttons are accurately set, the center distances of the holes will also be accurate, as they are bored concentric with the buttons. A piece of wire *C* (Fig. 4) is next turned to fit the taper hole in a collet, as shown, after which both the collet and wire are placed in the lathe spindle, the face-plate is removed, and the end of the wire is turned to a close fit for the holes in the master-plate. The face-plate is again screwed on the lathe spindle, and the master-plate is strapped to it with the wire plug *C* in its center hole. The recess *d* (Fig. 7) is now turned in the plate after which it is removed

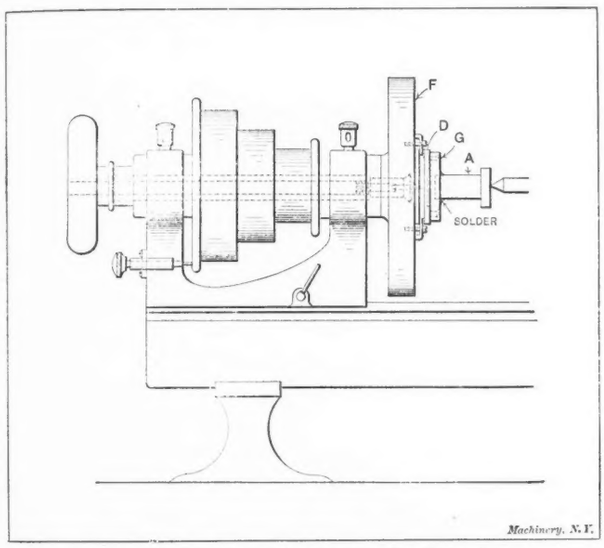


Fig. 9. Master Plate and Jig strapped to Face-plate

so that the four 3/16-inch screw holes shown may be drilled and tapped in its outer flange. A brass piece *G* (Fig. 8) is next turned and a shoulder is formed on it which is an accurate fit in the recess *d* in the master-plate. Four elongated holes are also milled in a piece *G* to match the holes in the flange of the master-plate. Piece *G* is then fastened to the master-plate, and the latter is strapped to the face-plate of the lathe, with the wire plug *C* in its central hole. A recess is then bored in *G* to an accurate fit for the small end of jig *A*, which is then soldered to *G* while the tail center is against the end, as shown in Fig. 9. The master-plate is now shifted so that one of the four outer holes fits over the wire plug in the spindle. When the master-plate is changed to a new position, care should be taken to see that no dirt or chips get between it and the face-plate, as these would, of course, impair the accuracy of the work. One of the four holes is now bored, reamed and counterbored in jig *A*. In the same manner the remaining three holes are finished, and, obviously, their location will correspond to the holes in the master-plate. When the holes are finished, the jig is easily removed by turning off the solder with a side tool. The master-plate should now be placed in its central position and a larger recess turned in *G* to fit the shoulder on jig *B*. This jig is then soldered to *J*, and four holes are drilled in it in the same manner as described for jig *A*. In a continuation of this article, a method of drilling holes in a hardened die, which was employed for special reasons, and also the way in which the drilled holes are ground, will be explained.

* * *

Plans have been approved by the Swiss State Railways for building the Hauenstein Railway, which will shorten the route from St. Gotthard to Basilea by about 40 miles.

INDUSTRIAL EDUCATION—INCREASING THE SUPPLY AND EFFICIENCY OF MACHINISTS—THE CINCINNATI PLAN*

F. A. GEIER†

The rapid development of the manufacturing interests of our country during the past decade, particularly in the metal-working lines, is yearly increasing the problem of finding an adequate supply of labor, and of a proper degree of efficiency. The system of education in this country has not, until the recent past, taken cognizance of the change of the requirements of labor that has come about through this industrial development. Manufacturers have for some time realized that the efficiency of the labor that offers itself for employment is not as high as it should be. To a large extent this is due to the fact that the great majority of applicants have not gone beyond the elementary schools, and are not prepared to meet the problems that confront them upon entering the manufacturing establishments. The courses of these elementary schools, have not been such as to hold the interest of the boys, a great many leaving the schools entirely too young and with a very poor foundation even in the rudiments of education.

Manufacturing processes are becoming more highly organized and while there is a greater subdivision of labor, I believe it is true that we need a working force to-day of greater general intelligence than in the days when simpler machines and simpler processes were employed in producing our work. A careful analysis of the conditions in any manufacturing plant, will reveal a tremendous waste, because of the abuse of machinery and tools, a low standard of work, spoiled pieces, etc., a great part of which waste could be eliminated if there were a higher degree of intelligence on the part of the workmen.

America has led the world industrially, because of the natural advantages of a large home market, and of its superior advantages as to cost of raw materials. Europe and notably Germany, largely offset our natural advantages by a superior training of its employes. Our advantages as to sources of raw materials are lessening year by year. If we are to increase our home and foreign trade we must train our employes better. The movement to this end has begun, and I am asked to speak to you more specifically as to what has been done in Cincinnati.

Cincinnati has the oldest mechanics' institute in this country. This institution, with its night classes, has been doing pioneer work along these lines for many years. It is, however, not a natural condition for young men to be compelled to get their education in this way. Boys attending these schools, tired out from the day's work, cannot make the progress that they should, and often become discouraged.

About four years ago the Board of Education of Cincinnati established manual training in the elementary grades. Two magnificent technological high schools are about completed, and in these schools such training will be given as will be exceedingly useful to the boys, as they subsequently enter manufacturing establishments. The courses comprise woodworking, metal working, foundry work, mechanical drawing, and such allied branches as physics, chemistry, etc.

You all know about the cooperative course for engineering established three years ago at the University of Cincinnati, in which boys who have passed through the high schools can enter this six-year course, working one week at the shop, and one week at the university, earning, during the period of six years, about $1,800. About 200 of these boys are now employed in Cincinnati shops. While there are exceptions to the rule, as a class, these boys have surprised their employers as to the character and quality of work they are able to do. In fact, the experience has been very satisfactory. Right in the beginning there was considerable skepticism on the part of the manufacturers and a reluctance to accept these boys. The shops to-day are offering to take on more new men than the university facilities can take care of at present.

In our own plant, we have found some of these boys available for some of our difficult work, and this is also true in

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

† President of the Cincinnati Milling Machine Co., Cincinnati, Ohio.

other shops. I call attention to this because the experience with these engineering students has practically demonstrated to the Cincinnati manufacturers the value of educated and properly trained young men. The great mass of our employes, however, in the future, as in the past, will be supplied from those who only complete the elementary courses.

About three years ago the firm of Houston, Stanwood & Gamble established a school in their own shop, giving instructions to their apprentices during shop hours. Their experience was so profitable that about a year later the Cincinnati Milling Machine Co. established a similar school. We first attempted to operate this school at night, but because of the difficulty of insuring an attendance on the part of the boys, we soon decided to also operate this school during working hours. These two schools were noticed by other manufacturers, and were also brought to the attention of the Board of Education. After a number of conferences between the manufacturers and the members of the Board of Education it was decided, beginning with September, to operate a continuation school under the auspices and at the expense of the Board of Education. It was agreed by the manufacturers that they would send their apprentices and other young men to this school four hours per week, paying regular wages while the boys were in attendance. Over 200 boys are now enrolled and as fast as additional teachers can be provided, there is no doubt that this enrollment will be very greatly enlarged. You must remember that at present the boys that attend the Cincinnati school are all employed in machine shops. The course has not yet been brought to embrace the other industries in Cincinnati. These classes of this continuation school are limited to about 20 boys. They are taught elementary and higher mathematics, including problems in geometry and trigonometry. The whole plan of the school is to teach directly the problems that the boy encounters in the shop. The catalogues and blue-prints of the machine manufacturers of Cincinnati are the text-books, and through the cooperation of the superintendents and engineers employed in the shops of Cincinnati, the work done at this school to-day is probably more practical and more effective than of any school in this country and Europe.

The efficiency of these boys in the shop is already showing substantial improvement, and will increase as the teaching force and courses at this continuation school are amplified.

So much for the efficiency. Now as to the increase in the supply of labor. It was formerly exceedingly difficult to secure a sufficient number of candidates for apprenticeships. You can readily see that parents whose attention is now called to this new plan appreciate at once that here is an opportunity for their sons to learn a trade, and at the same time to supplement their education. It also appeals to the boy. He wants to go to work, and while heretofore he has been indifferent to his studies at school, he now finds instruction that is alive with interest. The supply, therefore, of young men to learn the trade is more than sufficient. So much already has been accomplished that I look forward to the future with much hopefulness, and I sincerely trust that other communities will rapidly imitate Cincinnati.

Let me repeat, that the big problem before manufacturers of this country is to secure a larger and more efficient supply of labor. Industrial education is the remedy.

* * *

Young (college) men who work in any first-class establishment find that men who cannot talk grammatically, that men who chew tobacco, slouch along the street with greasy overalls on, who hardly look up, who are scarcely willing to speak to you politely as you go along, are intellectually as clear as they are. That is what the young men learn. I remember very distinctly the perfectly astonishing awakening at the end of six month of my apprenticeship, when I discovered that there were three men in the paintshop, I being the fourth, who were all smarter than I was. Now when a young man gets it clearly in his head that he is made of the same clay as those other men, then his only hope, not to be outstripped, is in better education. He sees clearly enough, if he uses his eyes, that it is energy, grit, pluck, determination, ability to stick to it, character, which makes success in the manufacturing and in the engineering world.—*F. W. Taylor.*

INDUSTRIAL EDUCATION—INCREASING THE SUPPLY AND EFFICIENCY OF MACHINISTS—THE FITCHBURG PLAN*

M. A. COOLIDGE†

The Fitchburg‡ plan of cooperative education, or cooperative industrial education, as applied to mechanics, is an arrangement between the high school and the manufacturers of metal machinery, saws, engines, pumps and condensers, and other metal products, for a four years' course of apprenticeship, the first year all school work, the next three years school and shop work, one week in school and one week in the shop. The boys work in pairs—as an example, if a shop takes eight apprentices it has four working at all times. The boy going to work next week goes to the shops on Saturday before closing time, for an hour or half hour, according to the nature of the work, and watches the job his alternate is on, and then is prepared to take up on Monday morning the operations he has previously made himself familiar with, having obtained the additional information he may need from his foreman.

When the shops are able to take a sufficient number of operatives under this system, the course can be very much improved, we believe, by a special instructor in each shop whose only duty will be to attend to his boys, giving them all the time and attention necessary. We expect to carry out this feature shortly.

The Fitchburg plan differs from the trade school idea where any student may enter and go wholly through a three years' course without regard to his mechanical ability or fitness for such work, whereas we drop out the dead wood and try to bring out every boy a good, high grade mechanic. In one trade school they wanted some plumbing done in the school itself and, though they taught plumbing in this very school, they had to send out and get a plumber to do the work. With the exception of the Williamson school in Philadelphia it is, as far as I have heard, the only one where the shop part is made at all prominent.

Manual training schools have also failed in their effort to do practical work along the line of the Fitchburg plan primarily, I believe, for two reasons: They have failed to put the shop part on an equality with the academic and were not able to work under real commercial conditions. Under the Fitchburg plan the boys are paid for their time in the shops 10 cents per hour the first year, 11 cents the second year, and 12½ cents the third year. The young man taking this course has just the same standing in the high school on the football team, athletics, lectures, and all advantages as the other students and put it all over the other boys by always having some real money to do as they wish with, and enjoying that feeling of independence, human in us all.

The apprenticeship or school year commences July 1 and for two months it is a trial period exactly the same as in our former apprenticeship systems. If the boy does not care to continue he may stop, and if the manufacturer feels that he will not make good as a mechanic, he is told so. If he continues, he is under the same apprenticeship bond to go through the three years' course as formerly. We believe this form of bond, or obligation, is just as valuable as formerly, and is kept in mind by the apprentice that he has entered into a business agreement, approved and guaranteed by his parents.

The four years' course follows:

	Periods per Week
First year, all school work—	
English	5
Current events; industrial history	2
Arithmetic, tables and simple shop problems	5
Algebra	5
Mechanics, simple machines	3
Freehand drawing	6
Second year, school and shop work—	
English	5
Industrial history, civics, American history	3
Shop mathematics	7
Physics	4
Mechanism	5
Freehand and mechanical drawing	6
Third year, school and shop work—	
English and industrial history	5

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

† President of the Fitchburg Machine Works, Fitchburg, Mass.

‡ See MACHINERY, October, 1908, and August, 1909.

Shop mathematics	5
Physics	4
Chemistry	4
First aid to injured	1
Mechanism	5
Freehand and mechanical drawing	6
Fourth year, school and shop work—	
English	5
Shop mathematics	5
Physics, electricity	4
Chemistry	4
Commercial geography and business methods	2
Mechanism	4
Freehand and mechanical drawing	6

The above scheduled studies, detailed as follows, show how interesting and instructive the school work may be made:

English: Throughout the four years' course in order that he may speak and write intelligently, forms of business papers, shop terms and spelling.

Mathematics: Simple tables, lengths, areas, volumes, metric system, circular measure. General shop mathematics dealing with problems on cutting speeds and feeds, gearing, belting, strength of material. Algebra to facilitate in working out shop formulas.

Mechanism: Parts and construction of different shop tools, gearing, cutting threads, forms and action of cutting tools.

Freehand drawing: For quick shop sketching.

Mechanical drawing: To help in reading blue-prints and make up shop drawings if necessary.

Industrial history: History of iron industry, factory system and labor problems, new inventions, reading mechanical journals to keep in touch with progress in mechanical affairs.

Physics and chemistry: As applied to everyday shop practice, simple and common methods of testing iron and steel, hardening and tempering.

Commercial geography: Centers of machine manufacture, source and cost of materials, labor conditions, railroad systems, waterways and cost of transportation.

William B. Hunter, a technology man, with ten years practical shop experience, is the special instructor in charge of this work, and the subjects taught in the course as just outlined are from special text books following the shop work very closely, cutting out the old academic studies entirely.

Joseph G. Edgerly, for thirty-five years superintendent of the Fitchburg schools, has done everything possible to make this cooperative plan a success, and it has proved, up to date, that this idea as outlined is the best course along cooperative lines.

The city authorities, high school committee, high school principal, teachers, citizens, and various organizations, have done all possible to make it such a success that the apprentices, their parents, and the manufacturers seem pretty well satisfied that here is a line of study and work on an actual commercial educational basis.

The scheme is adopted and worked out to fit our conditions along University of Cincinnati lines, as conducted by Prof. Herman Schneider, to whom we owe a great courtesy for the attention he has shown us.

* * *

HOW JOHNNY FORCED IMPROVEMENTS

E. B. GAFKEY*

At one time when the writer was roving around the eastern part of the United States, he happened to find a position with a firm that manufactured a line of small machinery and factory supplies. The man that built the shop had the foresight to take advantage of an unfavorable location, for the factory was located on the side of a hill, with the railroad siding on top. The shop was two stories high on the railroad side, and four in the rear. Our heavy tools, erecting and shipping rooms were on a level with the shipping platform, while the light tools were placed in the two stories below and were connected with the receiving platform by slides or chutes lined with light tank plates. The company used a vast quantity of small castings and forgings, which they did not make. These were received in barrels and boxes which were unloaded from the cars to the platform and thence down the slides to their respective departments where they were machined, finished, and placed in storage bins for use when wanted.

Our superintendent was a man, who, according to the way he talked, had never had a man in his employ who had ever done a fair day's work for the firm. He said they always worked and walked as though they were going to a funeral; but as no one paid any attention to him, we took it for granted that he was a natural grumbler, and let it go at that. However, one day things took a change, and it all happened on account of a small casting and a sharp order to hurry up, and the order didn't come from the superintendent either. That particular day my partner and myself were assembling a machine, when one of the parts used proved to be defective, and our helper, whose name was Johnny, was told to go downstairs and get another, and to be quick about it. He was quick, all right. Instead of going down the elevator or stairs, of which there were two of each, he went into the gangway at the top of the chutes where someone had left a scoop. Here was a chance. What's the use of going down two flights of stairs or waiting for a pokey elevator? Why not slide down? So suiting the action to the word, he seized

"The superintendent tried to dodge, but couldn't make it, and Johnny caught him just below the midship section"

the scoop, and after firmly seating himself therein, he placed the casting in his lap and "cut loose." Well, I suppose everything would have been all right, but when Johnny reached the bottom he had attained a speed of about fifty miles an hour, and it happened, at that instant, that the superintendent was just in the act of crossing his path. The superintendent tried to dodge, but couldn't make it, and Johnny caught him just below the midship section. The next instant there was a deafening crash as superintendent and Johnny landed in a pile of empty barrels stored near by. About two seconds later, Tom, the foreman of that floor appeared with "What the h—l is that leather-headed clerk sending material down here for without letting me know?" But there was no material in sight. Johnny managed to get out of the wreck first, and then stood in open-mouthed wonder, his eyes as big as moons, expecting to get fired; but nothing of the kind happened. The superintendent, with Tom's help, managed to scramble to his feet, and as he shook the loose barrel hoops from his person, straightened up as far as his one unbroken suspender would allow and says, "Well, I'll be d——d. There is nothing so important around here that any one has got to be so quick that they have to use that blamed slide."

Johnny got his casting and returned, while the superintendent went home to change his dishevelled appearance, but inside of fifteen minutes after the affair happened, the shipping clerk posted two big, glaring notices about the danger of using the slides, and that afternoon the millwright put up a sliding gate in front of them, with an electric bell at the bottom that would always ring when the gate was up. But that was not all. The next day, a gang of electricians appeared on the scene and installed a complete telephone system connecting the different departments.

One day shortly after, my foreman came to me and said: "Ted, that helper of yours deserves a medal. By using the superintendent to break up a few old barrels, he got more improvements in five minutes than all the foremen in the shop have been able to get in the last five years." We never heard any more talk of "moving faster" from the superintendent.

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LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

DEFECTS IN JIG DESIGN

The first consideration of the jig designer should be to determine what degree of accuracy is absolutely essential in the part that is going to be produced and also whether absolute interchangeability is necessary. This information will be a guide for the economical production of the jig. The designer should also consider any operations which are to be performed on the work prior to the one for which the jig under consideration is intended; for while this preliminary machining may not need to be accurately done, inaccuracy or ununiformity may result in improperly locating the work in the next jig, which should be so designed as to locate the part with the required accuracy. The writer's experience is that many jigs have been designed by those who have not considered the points mentioned in the foregoing.

Again, the locating parts of any jig should be such as to allow as wide a range of inaccuracy on any preceding operation which may be performed, as is compatible in the part. For example, if the part has to be turned to say a limit of 0.001 inch, it will require more skill and time than if a limit of 0.005 of an inch is allowable. Again, as far as practicable, the portion of the work that requires to be the most accurate should be used in locating it in the jig for the succeeding operation. Often a surface is selected to locate from which,

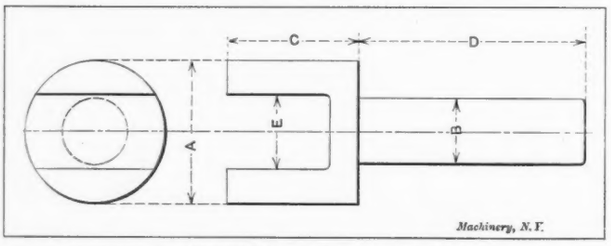


Fig. 1. Work which is milled as indicated at E

in consequence, has to be machined to an accurate limit, but which accuracy otherwise would be unnecessary. This, of course, only adds to the cost of production. After considering the points mentioned, the best method of arranging the details of the jig so that it has as few dimensions as possible requiring absolute accuracy, should also receive attention. That is, the jig should be as simple as possible, and still be so

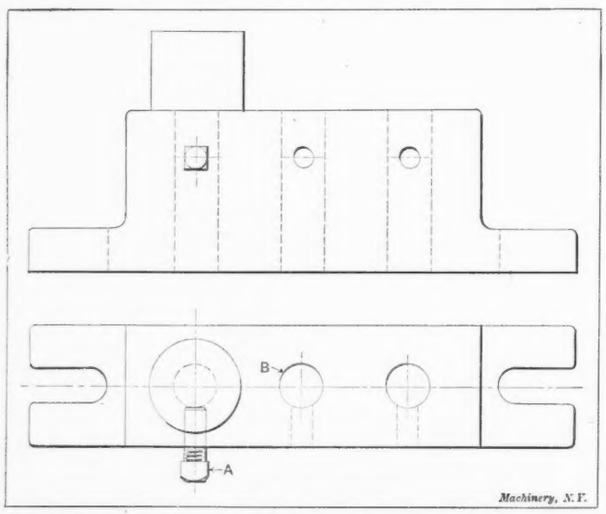


Fig. 2. Defective Design of Fixture for Holding Piece shown in Fig. 1

designed as to accurately locate the parts to be machined. Sometimes jigs are so designed that owing to the arrangement of the details, much time is expended in making test pieces to determine their accuracy.

In Figs. 2 and 3 are shown two jig designs which will serve to illustrate the points we have in mind. The part for which a jig is required is shown in Fig. 1. In the preliminary machining operation the work is turned to diameters *A* and *B* and to lengths *C* and *D*. The limit of accuracy required on end *A* is —1/64, or any diameter from 1 39/64 inch as a minimum to 1⅝ inch. For end *B* a finer limit of — 0.002 is necessary, so that this end should be used as the locating part for the next operation; *viz.*, the milling out of the slot *E* which must be central with the part *B*. A design

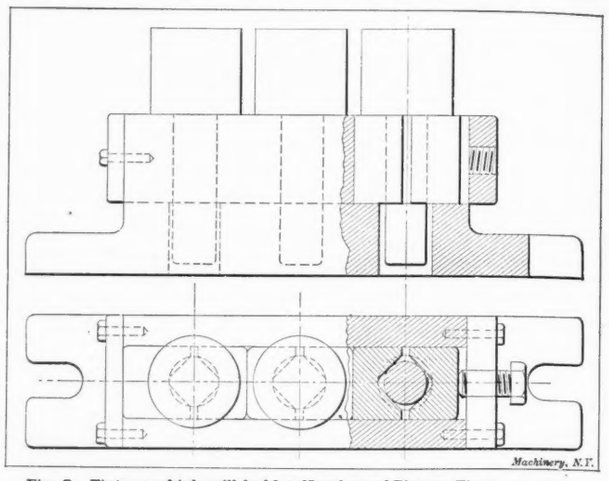


Fig. 3. Fixture which will hold a Number of Pieces, Fig. 1, properly, even though Diameters of Locating Parts vary

such as shown in Fig. 2 is not uncommon for this operation, and with it fairly accurate results will be secured; but if we assume that the locating diameter on the work is slightly small, say 0.002 inch, then forcing the piece over to one side by the locking screw *A* will result in an inaccuracy in the milling operation. The locating holes *B* must be the exact size of the locating part of the work, and unless every piece is a push fit (which is unnecessary accuracy in the part) the location is not accurate as the work is clamped against a

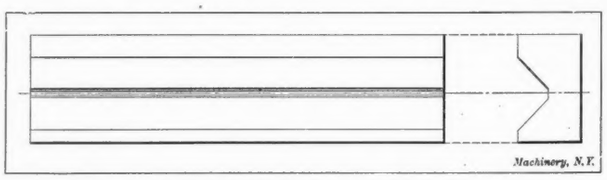


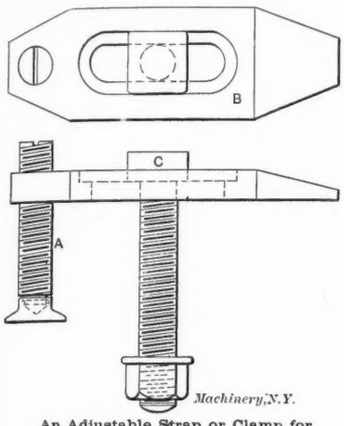
Fig. 4. The Way the V-blocks for the Jig, Fig. 3, are planed

small area on one side of the hole and the point of the set-screw on the other. This can be avoided by locating the part against V-blocks as shown in Fig. 3, which locate each shank central, irrespective of the variations in their diameters. The construction of this jig illustrates the points which have been referred to. The V-blocks provide four lines of contact, and the part is secured very rigidly in a central position irrespective of the variations in the diameter of the locating part. This jig, though more expensive than the one shown in Fig. 2, is quite simple in its construction. A central slot is machined to a width which need not be to any particular dimension as the steel V-blocks will be accurately fitted to this slot. Steel plates are secured to the ends of the jig after machining the slot as shown. By closing these ends after the slot is machined, the tool has a clear passage through, which, of course, would be impossible were the ends cast on. The V-blocks are planed in one piece, as shown in Fig. 4. The only important dimension is the width of the block. The exact position of the V in relation to the sides is immaterial provided that after the blocks have been sawed off they are inserted in the slot in the jig with the long or short sides together. To avoid trouble from this source, one side of the slot and a corresponding side on the blocks should be marked to ensure the correct insertion of the latter. In the event of a design requiring the V's to be strictly central with the sides, the cost would, of course, be increased, as much more care would be required in machining. The jig shown in Fig. 3 is for holding three of the pieces shown in Fig. 1 at one time. Obviously, this number could be increased as desired.

CONTRIBUTOR.

AN ADJUSTABLE STRAP

One of the neatest and most convenient face-plate straps that I have seen is shown in the engraving. How tiresome it is to hunt around the shop after blocks and pieces of the right height to line up the strap to a parallel position with the work to be machined. As will be seen, the rest *A* of this strap is easily adjusted to the proper height. Another desirable feature is that the oblong hole for the clamp bolt permits the strap to be located in the most desirable position by sliding it to and fro. A set of these straps of different sizes can be made with little extra expense, which will be more than offset by the saving in time. The strap *B* should be made of tool steel so that it will be stiff, and the elongated hole should be milled to fit the head of the bolt *C* in order to avoid the use of two wrenches and facilitate the handling of the work. The end of the strap is drilled and tapped for a suitable sized screw *A*, which has a shoe on the bottom to prevent marking the face-plate. This shoe is held in place with a pin to keep it from dropping off. A. L. MONRAD.



An Adjustable Strap or Clamp for the Face-plate

East Hartford, Conn.

A LATHE SPINDLE KINK

There is one very simple point in connection with the manufacture of lathe and milling machine spindles which builders in general would do well to consider, as I think it would result in great good to the Christianity of machinists and toolmakers, as well as being a profit producer to users of these machines. In order to briefly state the case I will relate a circumstance that occurred in actual practice, which is similar to several others of my own experience.

A new lathe had been in the shop for a considerable time, and when I had occasion to put the face-plate on the spindle I found it to go extremely tight, in fact it would not go up to the shoulder, which was, of course, aggravating and also a hindrance to progress; then I proceeded to take it off and spend about five minutes trying to clean the dirt out of the internal threads, though not succeeding very well. I finally wound up by getting out of patience and doing the job with the face-plate standing away from the shoulder. At my first opportunity I said to a toolmaker: "What is your private opinion as to the proper shape for the starting end of a thread on a lathe or milling machine spindle?" to which he replied: "It's a small question, I never gave it a thought." Then I told him of my grievances with the tight face-plate and he told me that when that lathe came into the shop the chuck and face-plate both went on all right and it was his opinion that someone must have strained the first thread. My convictions on the subject were that if the end of the thread were cut off straight instead of being left wedge-shaped (as it commonly is), the blunt end of the thread would scrape all the dirt out of the chuck thread as it entered; therefore there would be no dirt left to wedge in the thread, which was the cause of the tightness. The toolmaker was open for conviction and asked me to show him, so I took a small chisel and started at the place where the thread came to its full size and cut out a piece of the first thread about one inch long, which left a gap or open space in the thread. We then put the face-plate on and found that it went easy clear up to the shoulder. When the face-plate was taken off again, the gap in the thread was nearly filled up with dirt and chips which the end of the thread had scraped out. This spindle will always clean the thread ahead of itself and it is a source of permanent economy.

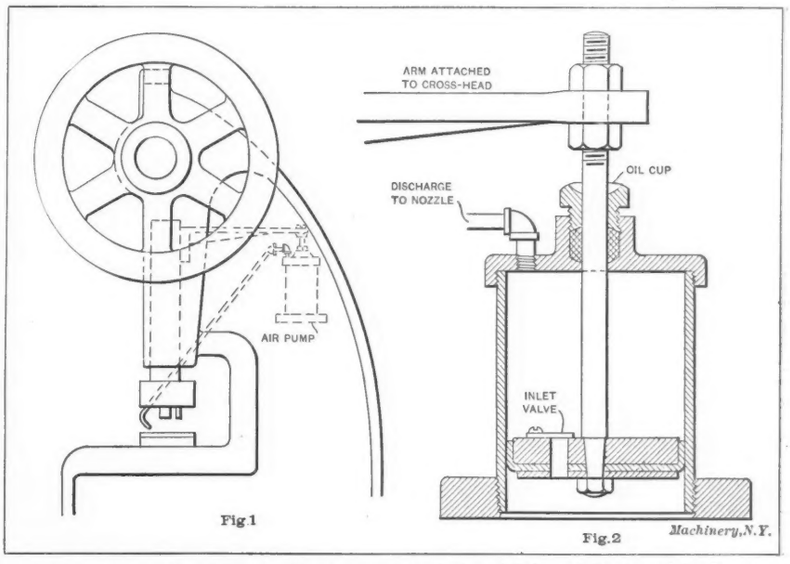
We take it for granted that a man should not put a chuck or face-plate where it will get dirt into it, but that does not change the fact that he will do it just the same; first because of carelessness, and second because he has something else to do besides taking care of the tools. Then again, even though all possible care is used, dirt will sometimes get into the threads so that it is better to adopt this simple method and put a stop to all future troubles in this line.

Here is another valable pointer concerning threads. In many cases where case-hardened finished nuts are used on soft bolts for the planer, slotter, milling machine, or almost any machine in the shop (especially where oil is used) the finer chips will accumulate in the nut with the result that the nuts are soon tight, and someone is blamed for straining the bolt. After a hand die is run over the bolt, if the nut is still tight, some have been known to get the tap and try to put it through the case-hardened nut. Here is a little kink that will overcome the difficulty: Take the corner of a file and file a notch down to the bottom of the thread of the bolt and in the majority of cases the nut will go on easily. The notch does not need to be large enough to damage the strength of the thread very materially.

Bridgeport, Conn. H. E. WOOD.

EJECTING WORK FROM THE PUNCH-PRESS WITH COMPRESSED AIR

The article by Mr. Barnes in the August number of MACHINERY descriptive of an arrangement for blowing away finished stock from a punch-press, recalls to the writer's mind a device designed and built by him to accomplish the same result. As there was no compressed air of sufficient pressure available, an independent pump was attached to the press, as shown in Fig. 1. The piston-rod of this pump is connected directly to the cross-head of the press, and, consequently, the pump has the same stroke as the throw of the crank-shaft. The air is compressed on the up stroke, and it is delivered against the work by means of a ⅛-inch pipe which is fitted on the end with a nozzle. The pump cylinder is made of a piece of 3-inch brass tubing which is screwed into a base-plate, as shown in the enlarged sectional view, Fig. 2. This tubing is fitted with a head containing a stuffing box, and a ⅛-inch pipe outlet. The piston is a regular 3-inch hydraulic cup, and a piece of leather belting is used as packing. A piece of leather fastened by one screw to the inside of the piston, covers a ⅜-inch hole and acts as an inlet valve. The finished work has an upturned portion on the front end, and the nozzle is



Side Elevation of Punch Press with Air Pump attached, and Enlarged Section of the Pump

placed so as to direct the blast against this point. This arrangement has also been used to blow away small scrap.

Baltimore, Md. BENJAMIN E. TEALE.

HANDY TABLE FOR THE SOLUTION OF RIGHT-ANGLE TRIANGLES

The table below gives in a convenient form the rules necessary for solving right-angle triangles. To the toolmaker or apprentice who has not had the privilege of becoming familiar with trigonometry, it is put up in a very handy form for reference. There are a great many who do not understand the meaning of "square" and "square root," and who will find

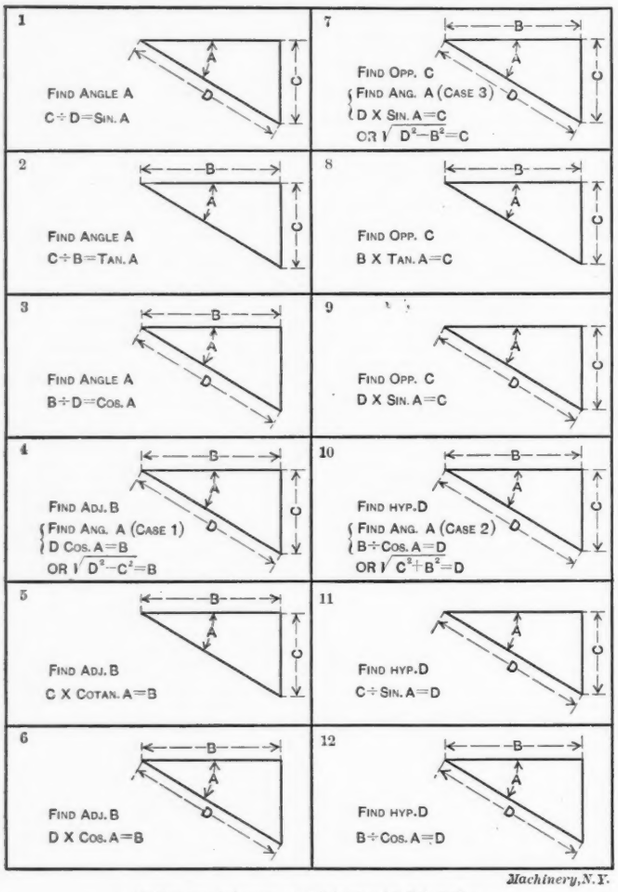


Table for Solution of Right-angle Triangles

it easier to first find the angle when two sides are given, and then find the required measurement of the third side from the angle by the rules as stated. It will be noted, however, that the formulas giving the length of the third side when two sides are given in the form of a square root is also included.

F. J. BOUVE.

Wenham, Mass.

FILING DRAWINGS

Commenting on recent articles by Mr. Breath and Mr. Davis on the sizes and filing of drawings, permit me to say that I have been employed where this matter was long ago settled in a very satisfactory manner. The filing cases used are 17 x 23 inches inside, practically, the intention no doubt being to have them 18 x 24 inches outside measurement. They are made of very heavy cardboard, cloth covered, and are sold by nearly all dealers in office supplies. Their supposed use is for the filing of legal documents, etc., as well as maps and drawings.

The largest drawings used are 16 x 22 inches, with a half-inch border all round, thus reducing the space inside the border to 15 x 21 inches. Then there are other drawings 8½ x 11 inches, the size of an ordinary sheet of letter paper. The filing cases cost a dollar and a half each, and open along one edge in a manner that permits of easy withdrawal of the contents. These filing cases are placed in a case on their back edges, so the contents are always in a vertical position. They occupy a minimum of office space in this way, and are very convenient for reference. The drawings are divided by subjects, and heavy folders such as are used in vertical filing cabinets are made from detail paper. The boxes containing the smaller sized drawings have a thin partition down the middle. When the scheme was started it was alphabetic and each envelope had on it the name of the work contained on the sheets of drawings in it. Now, however, the system is a numbered one, and there is a card index for reference.

Small drawings have come to stay because of their convenience, and this filing scheme I mention is certainly inexpensive and being on the vertical plan with heavy paper folders, is capable of indefinite expansion.

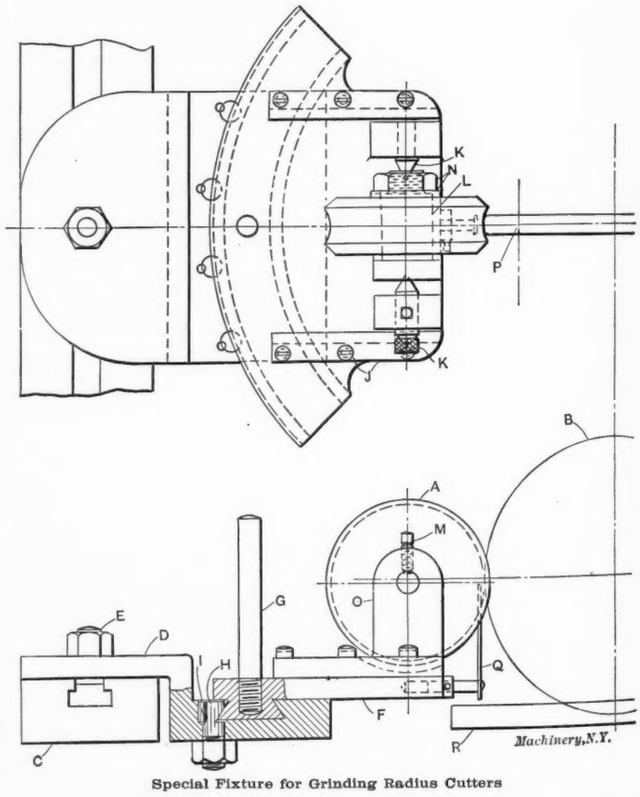
Chicago, Ill. JAMES DAVIDS.

FIXTURE FOR GRINDING RADIUS CUTTERS

Some of the parts on our automobile transmission which have to be milled can best be done with radius cutters, and as it is necessary to use an old grinder to keep these cutters sharp, this necessitated a fixture of rather an odd design.

The reason for this odd design in the fixture is that the grinder has no fixed method of adjustment, and this feature was rather hard to overcome, as it was absolutely necessary to have an adjustment to take in several sizes of cutters, and get a circular movement; provide for clearance; do without a pivot, and all perpendicular adjustment.

The construction of the fixture can be understood by referring to the engraving which shows a plan and a side view partially in section. The lines *A* represent the largest size cutter, and *B* the standard size of emery wheel for this grinder. *R* is a fixed table and *C* the platen with a horizontal



Special Fixture for Grinding Radius Cutters

motion only, which in this case was required to remain stationary. Thus it is seen that this grinder was not convenient for this class of work. The stationary support *D* for the fixture is clamped to the grinder by T-bolt and the nut *E*. *F* is a movable body, *G* a steel stud to be used as a handle in moving *F* back and forth in a semi-circle, *H* brass studs which are prevented from turning by dowel pins *I*, and which are beveled to fit the projecting tongue on *F*. As the four studs *H* are brass against cast iron, and in a corresponding radius to the tongue on *F*, provision is made for wear and accurate adjustment, while a circular or radius motion is obtained without a pivot. In this particular case a pivot

joint would necessarily come in the way of either the cutter *A*, emery wheel *B*, or table *R*.

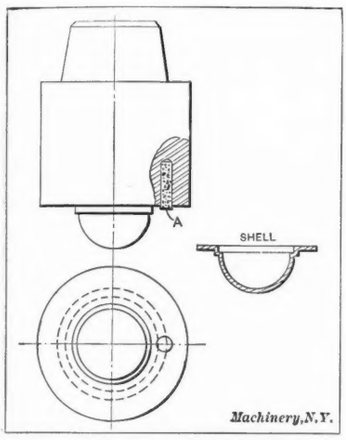
The required horizontal adjustment for the various size cutters is obtained by moving cutter holder *O* toward or away from the center *P*. This holder is clamped in place by side strips and screws *J*. The cutters are fitted to arbor *L* and clamped by a nut and washer *N*. The arbor is mounted on centers *K*, one center being movable for removing or replacing the arbor. The correct spacing is provided for by adjustable stop *Q*.

This gave us a practical fixture for this work on a machine of little value, and thus the fixture soon paid for itself.

JIG AND TOOL DESIGNER.

STRIPPING SHELLS THAT ADHERE TO THE PUNCH BY OIL CONTACT

A simple and very successful method used in connection with the drop press for stripping small shells that adhere to the punch by oil contact, is illustrated in the accompanying sketch. The principle is the same as that of the method described by Mr. C. Howell Dockson in the August number of MACHINERY, for stripping cup-shaped drawn shells, although perhaps of a cruder nature. The stripper consists of a stiff piece of rubber *A* inserted in a small hole in the punch, the end of which projects 1/32 inch below the surface of the punch. This rubber should be of proper size to hold itself in place by friction. In some cases it is preferable to locate the rubber in the center of the formed portion of the punch. Of course, the rubber has to be renewed occasionally on account of deterioration. The frequency of renewal depends on two things: Namely, the amount of pressure required to strip the shells and the grade of rubber used. It is safe to say that one rubber will do for from 1,500 to 2,000 gross of the piece being formed, without renewing. Rubber of the right size should be kept on hand so that worn-out pieces may be quickly replaced.

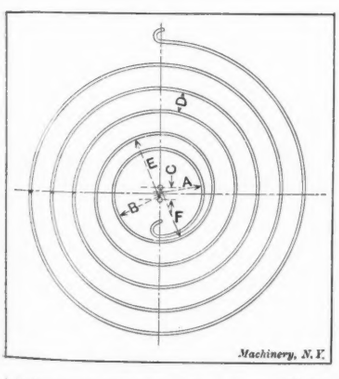


Punch with Rubber Insert A, which Sheds the Shell held by Oil Contact

Winsted, Conn. CHARLES RICHARDS.

LAYING OUT A SPIRAL

It is seldom that a draftsman has occasion to draw a spiral of many turns (like a watch spring) and when the occasion does arise, recourse is had to some handbook which usually gives the method of four centers. The use of the two center method with semi-circles, I find to be sufficiently accurate, much more rapid, besides giving a smoother job by reason of fewer joints. While this method is not at all new it does not seem to be commonly known. The engraving shows a drawing of a spring, made by this method. Starting at the inside with radius *A* from the actual center, draw a semi-circle at the right of the vertical line. With radius *B* (equal to *A* plus thickness of spring) find center below true center from which the arc will connect with the arc struck by *A*, and draw the semi-circle at left of vertical, thus completing the first turn. Having decided on the pitch *D*, two centers are next located on the vertical, one being ¼ *D* above true center, the other ¼ *D* below true center; thus $C = \frac{1}{2} D$. From the upper center with a radius *F* draw the semi-circle at the right of vertical and from the lower center with a radius *E* connect with end of arc *F*, and draw the semi-circle at the left. By thus changing centers and increasing the radii the spiral is easily produced. RALPH W. DAVIS.

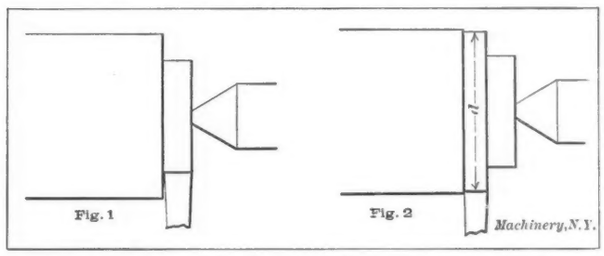


A Spiral Laid Out by the Two-center Method

Rochester, N. Y.

CUTTING A DOUBLE THREAD

Among machinists it is generally known that when the number of threads per inch of a screw being cut is an exact multiple of the number of threads per inch of the lead-screw, the split-nut may be disengaged at the end of each cut and re-engaged at random when beginning a new cut, there being no need to stop or reverse the lathe. In the case of screws having a number of threads which is not a multiple of the number of threads per inch of the lead-screw, it is necessary to have recourse either to some means of insuring the correct re-engagement of the split-nut and screw, as by the use of an indicator designed for the purpose, or by keeping the lead-screw and nut always in mesh and reversing the lathe, thus bringing the carriage and thread tool back to the starting point. It may not be generally known, however, that when the lead of a double-threaded screw is exactly twice that of the thread on the lead-screw of the lathe, such a screw can be cut without stopping or reversing the lathe or employing timing or other devices. To illustrate, if a double-threaded screw having say, ½-inch lead were being cut on a lathe, provided with a lead-screw of ¼-inch lead, the split nut could be engaged at any time and the tool would always follow in one of the two thread spaces.



Figs. 1 and 2. End of Blank turned to Depth of Thread and to Depth of First Cut

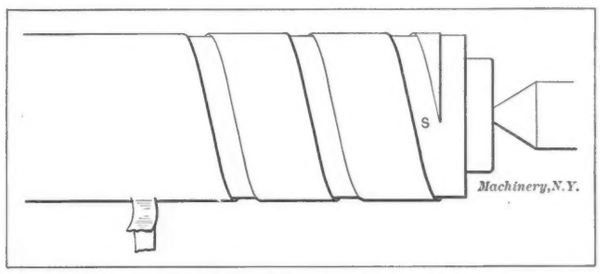


Fig. 3. Tool taking the First Cut on a Double-thread Screw

The accompanying engravings illustrate the method employed by the writer when cutting double threads, the lead of which is twice that of the lead-screw, which enables the work to be done very quickly. As shown in Fig. 1, the end of the work is first reduced to the diameter of the bottom of the required thread. In repetition work, this operation would first be completed on all the pieces to be threaded. It could, however, be omitted entirely if the lathe is equipped with an indicator or stop to give the exact depth. The practical man will no doubt have observed that in cutting a square thread, the moment the tool meets the work, it lags behind slightly. This is due to the fact that the tool is held up or is cutting at this moment only on its leading edge; consequently it yields more or less according to its stiffness or rather lack of stiffness. Hence it is often necessary to cut away a portion of the leading end of the screw. When performing the operation indicated in Fig. 1, allowance should be made for this distortion of the thread.

The next step is to reduce the end, as shown in Fig. 2, an amount equal to the depth of one cut. The split-nut is then engaged with the lead-screw at random, and the first cut taken along the work as shown in Fig. 3. When the carriage is brought back (by hand) to the starting point, the tool is set against the reduced end, as in Fig. 2, and the split-nut is engaged with the lead-screw immediately after the opening of the thread space *S* (Fig. 3) has passed the point of the tool. The tool will now take a second cut midway between the turns of the first, as shown in Fig. 4, and the depth of the second cut will also be equal to that of the first. When the tool is again started the diameter *d* (Fig. 2) is reduced an

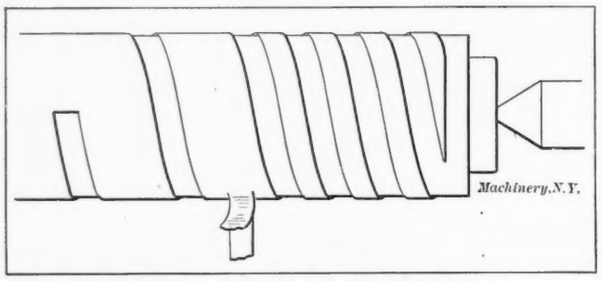


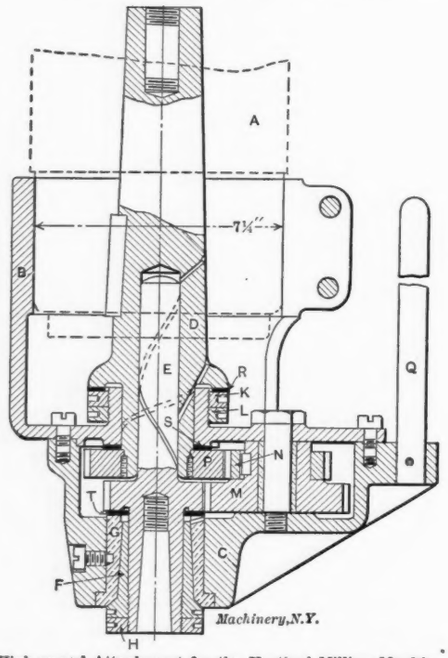
Fig. 4. Tool taking the Second Cut

amount equal to the desired depth of the cut, and the split-nut engaged at any point. Then when the succeeding cut is taken, it is again necessary to engage the split-nut at the proper moment; that is, when thread space *S* has just passed the tool. This operation is repeated until the thread is cut to the correct depth as shown by the coincidence of the tool point with the reduced end, or by a stop if the lathe is so equipped. In one instance within the writer's experience, the replacement of the old method by the one here described reduced the time per piece from about one hour to twenty minutes, or an increased output of 300 per cent.

Coventry, England. FRANCIS W. SHAW.

SPEEDING HEAD FOR VERTICAL MILLING MACHINE

The high-speed milling attachment illustrated herewith was designed to fit an Ingersoll milling machine, the spindle speed of which was too slow for some classes of work. The attachment is designed so that it is easily attached or removed

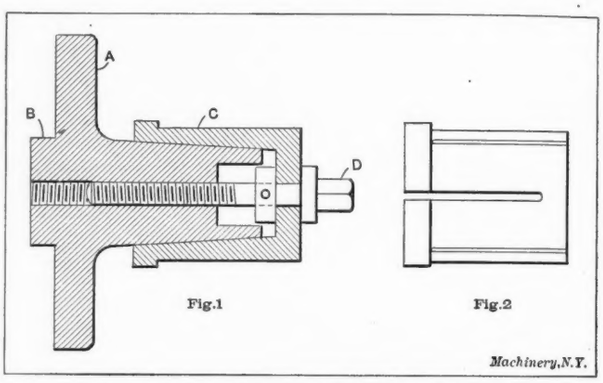


High-speed Attachment for the Vertical Milling Machine

from the machine. The following is a description of the construction of this attachment as made in the Thomson-Houston shop of the General Electric Co. The casting *B* was bored to fit the outside of the spindle *A*. The part *B* is fastened to the spindle by two bolts as shown. The gear case *C* is centered with the spindle by a boss on *B*, and it is bored out to receive the brass sleeve *G*, which forms a bearing for the conical, tool steel, hardened sleeve *F*; the latter is screwed on the milling cutter holder *E*. The upper end of *E* has a bearing inside the part *D* which fits into the spindle and is keyed to it. On *D* is fixed a gear *P*, which drives the holder *E* through the gears *N* and *M*. The attachment is prevented from turning in either direction by a stud *Q*, which comes into contact with the machine head. The box *C* forms a reservoir for the oil into which the hardened steel gears run constantly. Spiral grooves are cut in all bearings, and fiber washers are used at *R*, *S* and *T* as thrust washers. The nut *H* permits compensating for the wear that may take place in sleeve *G*. This device, as before stated, is very easily attached to the machine, and the only change that was necessary in the latter was to cut a keyway inside of the spindle for the key which drives the shank *D*. P. P. F.

FIXTURE FOR TURNING AND FACING COLLARS

As we have quite a number of collars to make, the fixture shown in the sectional view, Fig. 1, was made for holding them while they are being turned, faced and polished. This fixture has a disk *A* which is fastened to the lathe face-plate and centered by a boss *B*. The projecting end of this disk is turned to a taper of ⅝ inch per foot, and on this tapered part



Fixture with Expanding Sleeve for Holding Collars while Turning and Facing them

is fitted a flanged sleeve *C*. This sleeve has six ⅛-inch slots cut into it, three being cut from each end and extending to within ⅜ inch of the opposite end, as shown in Fig. 2. These slots permit the sleeve to expand when it is forced upon the tapered part by the screw *D*, which fits into *A*. As the collars for which the fixture was made are slightly longer than the expanding sleeve, they can be turned on the outside and faced on the end at one setting of the tool. They can also be very quickly placed on or removed from the fixture by simply turning the screw *D* in the proper direction. The ends of the collars can be easily polished, as it is not difficult to get in the corner with the polishing stick as when using an ordinary mandrel. One hundred collars were made on this fixture in ten hours' less time than was required when a mandrel was used. L. J. GETZ.

Salem, O.

DON'TS FOR SCREW MACHINE OPERATORS

Don't use a box tool for a roughing cut; use a hollow mill.

Don't use a cut-off tool without some top rake.

Don't put an extension on a wrench when trying to make a tool hold; if the tool slips after tightening with the proper wrench something is wrong.

Don't use a steel hammer for adjusting tools; have a copper one handy and some pieces of brass of different sizes and lengths.

Don't use a monkey-wrench; show the boss how much cheaper it is to standardize the screw heads and furnish proper wrenches.

Don't put a new bar of stock into the machine without measuring the first two or three pieces that come off.

Don't measure up a piece of work without measuring all of the dimensions.

Don't change collets or jaws without cleaning out the spindle nose.

Don't put a screw-driver into the slots of a feed finger to loosen it; use a spanner or a pin in the holes provided.

Don't use a cut-off tool which is too narrow; a wider one can be pushed faster and it will stand up better and leave a better finish.

Don't throw in the feed until you are sure everything about the machine is all right.

Don't let the first few pieces get by without looking to see if the feed finger is scratching the work.

Don't move a tool after measuring just one piece; it is better to measure two or three, as any automatic will make a piece now and then which will be out.

Don't put a new bar of stock into an automatic in a haphazard manner; different jobs require different ways of starting a new bar.

Don't let your machines run without measuring the work often.

Don't take two roughing chips if one is possible; use a little finer feed and only take one chip.

Don't let the tools get choked up with chips; clean them out once in a while.

Don't say you can't do a hexagon or a square job just because you haven't a collet; a round one will hold both square and hexagon on a pinch.

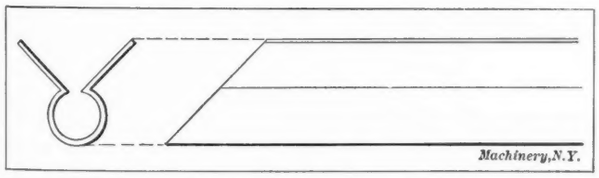


Fig. 2. Corner Piece formed by the Die shown in Fig. 1

Don't run the feed belts too tight; when a trifle loose, if something sticks they will slip and not smash things.

Wilkes-Barre, Pa. PAUL W. ABBOTT.

PRESS TOOL FOR BENDING CORNER PIECES

A press tool is shown in Fig. 1 for forming in one operation the copper corner-piece for lamp frames illustrated in Fig. 2. These corner pieces vary in length from 8 to 36 inches. The copper from which they are made comes in rolls cut to the width required, and they are cut to the right length in the press with an ordinary punch and die, which also forms the ends so that they will fit together when placed in position on the lamp frame.

The construction of this bending and forming die is clearly shown by the side and end elevations, Fig. 1. The forming punch *A* is fixed into punch-holder *B* by taper pins *C*. This punch is made in two pieces as shown in the end view. The punch *D*, which also acts as a mandrel on which the cylindrical part of the corner-piece is formed, is made a sliding fit in *A*. The two forming slides *F*, which fit in slots in the casting *H*, are normally held open by helical springs *J*, which are compressed between fixed studs.

When the press is on the upper part of its stroke, punch *D* is forced to the bottom of the slot in *A* by the springs *E*. As this punch descends, it bends the stock to a U-shape between the slides *F*, which are then forced inward by the finger-cams *G*, thus forming the corner-piece against the lower ends of *D* and *C*, to the required shape. While the slides *F* are at work, punch *D* moves upward with relation to the slot in *A*, and, at the end of the downward stroke of the press, it occupies the position shown. In order that *D* will not begin this upward movement as soon as it comes into contact with the stock and begins bending it, pins *K* are inserted into it which fit into the right-angle slots cut through one side of the punch *A* as shown in the side elevation. When the downward stroke begins, these pins are in the part *k* of their slots. When it is time for *D* to begin its upward movement, it is forced to the left by cam *L* so that the pins *K* are brought in line with and can ascend the vertical parts of the right-angle slots.

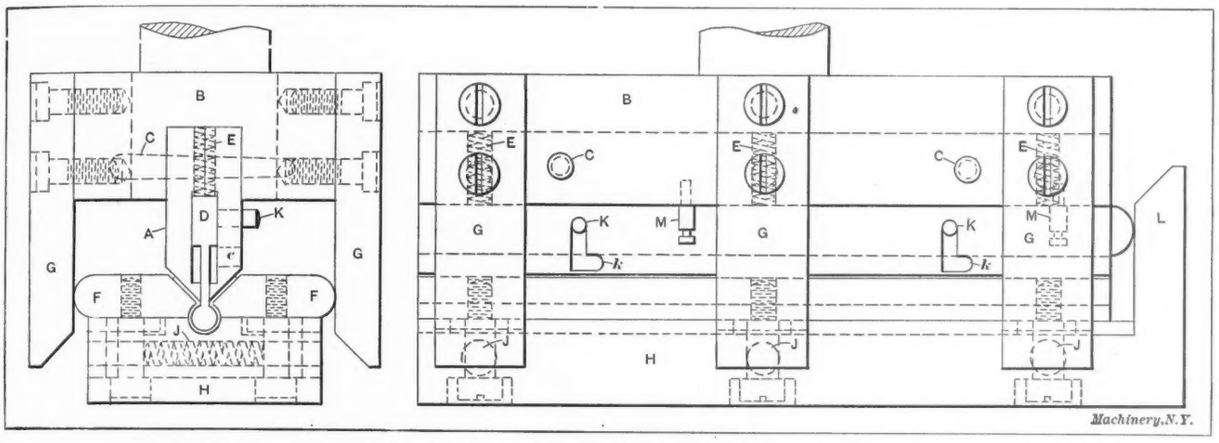


Fig. 1. Side and End Elevation of a Bending and Forming Die for Forming in One Operation the Piece shown in Fig 2

When the press begins the upward stroke, *D* begins to descend, being forced downward by the springs *E*. When pins *K* reach the bottom of the vertical part of their slots, springs (not shown) which are attached to them and to the pins *M* in the punch-holder, draw punch *D* to the right. The pins are then once more in the right-hand end of the horizontal part of the slot, or in position *k*; the punch is then ready to begin bending a new piece.

The gages or stop-pins for the stock are not shown, but are fixed on the slides *F*. These two slides come against a dead stop each time they are opened by the springs *J*. The punch *D* should be an easy fit in the slot in *A*, and the cam *L* should come in contact with this punch before it can bind the stock against the die, so that it can slide freely to the left or in a position that will enable *A* to descend. This tool should be used in a press having at least a 2- or 3-inch stroke, as it would not work well in a press having a shorter stroke than this. C. PETITJEAN.

London, E. C.

LATHE ATTACHMENT FOR BACKING OFF TEETH OF STEPPED REAMER

We had orders for about 200,000 gas cocks, the bodies of which had to be drilled and reamed. When this work was started there was considerable trouble as the reamer would clog up with chips and break because it had to remove so much stock in reaming the large end of the hole. In addition, the hole was distorted so much that there was always trouble when grinding the seats. This trouble, however, was eliminated after the tool shown in Fig. 1 was designed, which enabled the drilling and reaming to be done in one machine, and at the rate of 8 per minute or 480 per hour. This combined drill and reamer prevented the breaking of the finishing reamers and made it possible to grind the plugs in the body in one quarter the time previously required. It was necessary in order to secure satisfactory results to have the cutting edges on each side for the different steps, in the same plane, and in Fig. 2 is shown a diagrammatical view of the attachment used for backing off the cutting edges of the different

steps. It consists of casting *A*, which is threaded to fit the lathe spindle, carrying on its face two raised surfaces or cams *B*, which for this particular job are located 180 degrees apart. The shape of each of these raised surfaces corresponds to the required shape for the clearance. Bearing against the plate *A* and in line with cams *B* is a roller *C*, mounted in a shank which in turn is fastened to the cross-slide of the lathe carriage. The work *D* is held in a hole in the center of the casting *A* by suitable means. When the lathe is to be set for cutting clearance on the reamer, the roller *C* is brought in contact with the highest point of one of the cams as shown

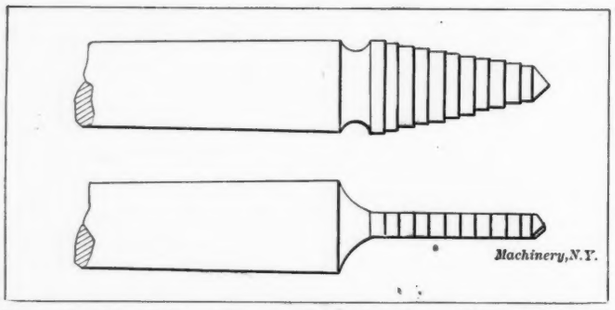


Fig. 1. Combined Drill and Reamer after the Turning and Milling Operations

in the illustration. The cutting point to be backed off and the turning tool are then set so that they just touch each other. By keeping a constant pressure on the hand-wheel at the side of the carriage, the cams as they come in contact with the roller will cause the carriage to advance and return at just the proper moment to give the required form to the cutting edges. Of course, if the work has more than two cutting edges to be turned, it will be necessary to have as many cams

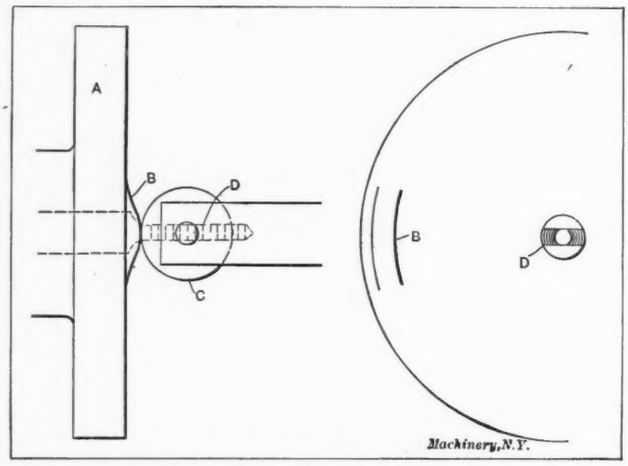


Fig. 2. Diagrammatical View of Special Lathe Attachment used for Backing Off the Reamer Teeth

as there are flutes. I have used this attachment for making forming drills for a large variety of brass cast work and it is the best thing that I know of for backing off cutting edges of tools of this type. JOHN M. FRUIN.

Waterbury, Conn.

DRAWING WITH CROSS-SECTION PAPER UNDER TRACING CLOTH

In the April number of MACHINERY there is a note telling about the use, in England, of tracing cloth with cross-section rulings. As many offices may not find it advisable to obtain a supply of this special cloth the following will doubtless be of interest. Take a sheet of first-class section paper with black ruling and fasten to the drawing board with small tacks. Place the regular tracing cloth over the ruled paper and draw directly on the cloth. In many lines of work it is possible to make the complete drawing in ink without the use of a pencil. I have seen entire switchboards of large size drawn in this manner. When drawing the detail parts such as angle irons, copper bars, rods, etc. (when the dimensions are important and the picture only a place to hang them) the ruled paper beneath the tracing will prove a great time saver. It is, of course, necessary for the draftsman to have his work clearly in mind, or a rough sketch before his eyes. RALPH W. DAVIS.

Rochester, N. Y.

BENDING FORM FOR SPIRAL SCROLLS

While visiting a small railing shop, where considerable scroll work is done, I saw a number of pieces with spiral ends, as shown in Fig. 1, and I could not imagine how they were

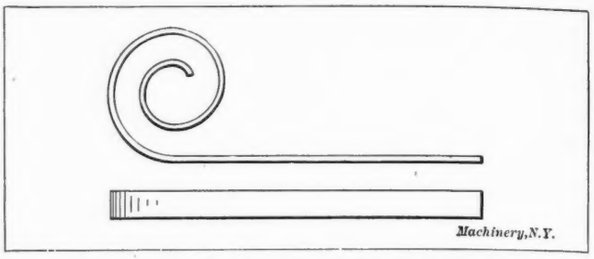


Fig. 1. Scroll which is bent on the Form shown in Fig. 2

bent, as it was a shop without power and equipped only with a few hand tools; yet the scrolls were an example of good workmanship. I began to look around and ask a few questions, when I found that the method of bending these scrolls was "as easy as rolling off a log." A piece of straight, flat stock was heated to a dark red, and then bent on a form, similar to that shown at *A* in Fig. 2, which was held in the vise. The work, after being removed from the form, was

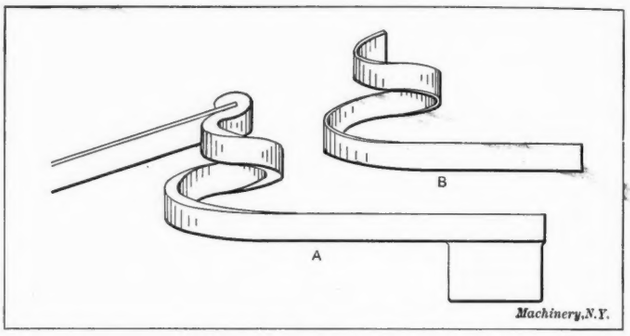


Fig. 2. Bending Form and Shape of Work before it is flattened

then in the shape of a conical spiral, as shown at *B*. In order to form the scroll shown in Fig. 1, the piece was simply flattened down on a straight plate. HERMAN JONSON.

New York City.

* * *

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The National Machine Tool Builders' Association held its eighth annual convention at the Hotel Astor, New York, October 12 and 13, with the following official organization: President, Fred L. Eberhardt; first vice-president, C. A. Johnson; second vice-president, E. P. Bullard, Jr.; treasurer, W. P. Davis; and secretary, P. E. Montanus. The list of members including the concern admitted to the association at this meeting follows on the next page.

President Eberhardt in his address referred to the Hudson-Fulton celebration and the great advances in transportation that this celebration commemorated. He referred to the position of the association favoring the reduction of the tariff on the metal-working classifications; and expressed the conviction that the government authorities in Washington—Department of Commerce and Labor—were impressed by the movement initiated in New York last year to bring to their attention the size, importance and needs of the machine tool industry. He expressed confidence in the future of the industry, it being evident that the trade depression has been passed and that good times are in sight. Paul E. Montanus, chairman, presented the report of the committee on standardizing electric motors as applied to machine tools, which was discussed by Mr. Lodge. The report in part was as follows:

"Regarding the maximum speed of motors, both constant and variable, and the peripheral speed of gears, the committee finds quite a diversity of opinion. From the report we find

that for constant-speed work the majority seem to favor 1,200 revolutions per minute on most of the smaller motors, at least up to five horse-power. There was, however, a difference ranging from 900 to 1,800 revolutions per minute. Where rawhide pinion is used it was found that the maximum speed was somewhat higher, but that still 1,200 revolutions per minute was most commonly used. With metal pinions this was somewhat lower.

LIST OF MEMBERS OF THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION

Allen, Charles G., Co. ..... Barre, Mass.
American Tool Works Co. ..... Cincinnati, Ohio
Aurora Tool Works ..... Aurora, Ind.
Automatic Machine Co. ..... Bridgeport, Conn.
Barnes, W. F. & John, Co. ..... Rockford, Ill.
Barnes Drill Co. ..... Rockford, Ill.
Bath Grinder Co., Inc. ..... Fitchburg, Mass.
Baush Machine Tool Co. ..... Springfield, Mass.
Besly, Chas. H., & Co. ..... Chicago, Ill.
Binsse Machine Co. ..... Newark, N. J.
Bradford Machine Tool Co. ..... Cincinnati, Ohio
Builders Iron Foundry ..... Providence, R. I.
Bullard Machine Tool Co. ..... Bridgeport, Conn.
Carter & Hakes Machine Co. ..... Winsted, Conn.
Champion Tool Works Co. ..... Cincinnati, Ohio
Chandler Planer Co. ..... Ayer, Mass.
Cincinnati-Bickford Tool Co. ..... Cincinnati, Ohio
Cincinnati Lathe & Tool Co. ..... Cincinnati, Ohio
Cincinnati Milling Machine Co. ..... Cincinnati, Ohio
Cincinnati Planer Co. ..... Cincinnati, Ohio
Cincinnati Shaper Co. ..... Cincinnati, Ohio
Colburn Machine Tool Co. ..... Franklin, Pa.
Davis, W. P., Machine Co. ..... Rochester, N. Y.
Detrick & Harvey Machine Co. ..... Baltimore, Md.
Dill, T. C., Machine Co. ..... Philadelphia, Pa.
Dreses Machine Tool Co. ..... Cincinnati, Ohio
Dwight Slate Machine Co. ..... Hartford, Conn.
Fairbanks Co. ..... Springfield, Ohio
Fellows Gear Shaper Co. ..... Springfield, Vt.
Fifield, G. W. ..... Lowell, Mass.
Fitchburg Machine Works ..... Fitchburg, Mass.
Flather & Co., Inc. ..... Nashua, N. H.
Flather, E. J., Mfg. Co. ..... Nashua, N. H.
Flather, Mark, Planer Co. ..... Nashua, N. H.
Foote, Burt & Co. ..... Cleveland, Ohio
Fosdick Machine Tool Co. ..... Cincinnati, Ohio
Fox Machine Co. ..... Grand Rapids, Mich.
Gang, Wm. E., & Co. ..... Cincinnati, Ohio
Gardam, Wm., & Son ..... New York, N. Y.
Gisholt Machine Co. ..... Madison, Wis.
Gould & Eberhardt ..... Newark, N. J.
Greaves, Klusman & Co. ..... Cincinnati, Ohio
Hamilton Machine Tool Co. ..... Hamilton, Ohio
Heald Machine Co. ..... Worcester, Mass.
Hendey Machine Co. ..... Torrington, Conn.
Henry & Wright Mfg. Co. ..... Hartford, Conn.
Hilbert Machine Co. ..... Cincinnati, Ohio
Hoefer Mfg. Co. ..... Freeport, Ill.
Ingersoll Milling Machine Co. ..... Rockford, Ill.
International Machine Tool Co. ..... Indianapolis, Ind.
Johnson, I. H., Jr., Co., Inc. ..... Philadelphia, Pa.
Jones & Lamson Machine Co. ..... Springfield, Vt.
Kearney & Trecker Co. ..... Milwaukee, Wis.
Kelly, R. A., Co. ..... Xenia, Ohio
Kempsmith Mfg. Co. ..... Milwaukee, Wis.
Kern Machine Tool Co. ..... Cincinnati, Ohio
King Machine Tool Co. ..... Cincinnati, Ohio
LeBlond, R. K., Machine Tool Co. ..... Cincinnati, Ohio
Lodge & Shipley Machine Tool Co. ..... Cincinnati, Ohio
Lucas Machine Tool Co. ..... Cleveland, Ohio
Lutter & Gies ..... Milwaukee, Wis.
Mechanics Machine Co. ..... Rockford, Ill.
Mueller Machine Tool Co. ..... Cincinnati, Ohio
National-Acme Mfg. Co. ..... Cleveland, Ohio
National Automatic Tool Co.* ..... Dayton, Ohio
Newark Gear Cutting Machine Co. ..... Newark, N. J.
Niles-Bement-Pond Co. ..... New York, N. Y.
Norton Grinding Co. ..... Worcester, Mass.
Owen Machine Tool Co. ..... Springfield, Ohio
Poole, J. Morton, Co. ..... Wilmington, Del.
Powell Tool Co. ..... Worcester, Mass.
Prentice Bros. Co. ..... Worcester, Mass.
Queen City Machine Tool Co. ..... Cincinnati, Ohio
Quincy-Manchester-Sargent Co. ..... Plainfield, N. J.
Reed, F. E., Co. ..... Worcester, Mass.
Reed, Francis, Co. ..... Worcester, Mass.
Rivett Lathe Mfg. Co. ..... Brighton, Mass.
Rockford Drilling Machine Co. ..... Rockford, Ill.
Rockford Machine Tool Co. ..... Rockford, Ill.
Schumacher & Boye ..... Cincinnati, Ohio
Seneca Falls Mfg. Co. ..... Seneca Falls, N. Y.
Sibley Machine Tool Co. ..... South Bend, Ind.
Snyder, J. E., & Co. ..... Worcester, Mass.
Springfield Machine Tool Co. ..... Springfield, Ohio
Steptoe, John, Shaper Co. ..... Cincinnati, Ohio
Stockbridge Machine Tool Co. ..... Worcester, Mass.
Von Wyck Machine Tool Co. ..... Cincinnati, Ohio
Walcott & Wood Machine Tool Co. ..... Jackson, Mich.
Warner & Swasey Co. ..... Cleveland, Ohio
Western Machine Tool Works ..... Holland, Mich.
Whitcomb-Blaisdell Machine Tool Co. ..... Worcester, Mass.
Whitney Mfg. Co. ..... Hartford, Conn.
Wilson, W. A., Machine Co. ..... Rochester, N. Y.
Windsor Machine Co. ..... Windsor, Vt.
Woodward & Powell Planer Co. ..... Worcester, Mass.

* Admitted at this meeting.

"It is with respect to the speed of motors and their variations we found the greatest difficulty at the joint meeting with the Electrical Association. The speeds were so arranged and based on the following suggestions: That the starting basis of constant speed of the A. C., 60 cycles be used as the basis of the D. C., constant-speed motors, and also that this be used as a basis for the working out of the variable speed requirements. The speeds suggested are 600, 720, 900, 1,200 and 1,800 revolutions per minute. These figures are not absolutely correct for the above condition, but are approximately close enough for discussion purposes. In all the speed tabulation it is understood that the variation of five per cent up or down can be allowed. The table which we submit below is the first and the basis upon which the two committees are working.

VARIABLE SPEED MOTORS

		Range			
H. P.	Max. Speed	4 to 1	3 to 1	2 to 1	1½ to 1
1	2200	550	740	1,100	1,480
2	2200	550	740	1,100	1,480
1	1800	450	600	900	1,200
2	1800	450	600	900	1,200
3	1800	450	600	900	1,200
5	1800	450	600	900	1,200
7½	1800	450	600	900	1,200
10	1800	450	600	900	1,200
2	1500	375	500	750	1,000
3	1500	375	500	750	1,000
5	1500	375	500	750	1,000
7½	1500	375	500	750	1,000
10	1500	375	500	750	1,000
15	1500	375	500	750	1,000
15	1200	300	400	600	800
20	1200	300	400	600	800
25	1200	300	400	600	800
30	1200	300	400	600	800
20	900	225	300	450	600
25	900	225	300	450	600
30	900	225	300	450	600
40	900	225	300	450	600
30	720	180	240	360	480
40	720	180	240	360	480
50	720	180	240	360	480

"In order to explain this table, we will take the 2-H. P. size. In it we will suggest the maximum speed as 2,200; the 4 to 1 range would therefore be 550 to 2,200; 3 to 1 range, 740 to 2,200; 2 to 1 range, 1,100 to 2,200; 1½ to 1 range, 1,480 to 2,200. This would require four motor frames to carry out this standard. If any manufacturer should decide that 2,200 revolutions is entirely too high, he has the following option:

"If he uses a 2 to 1 motor, he can use a speed variation as low as 500 to 1,100 or 740 to 1,480. If the 3 to 1 is required, he could use 550 to 1,480, or at least that frame. Therefore, it would seem that while the table may be somewhat high, the number of combinations which could be taken therefrom would be sufficient to meet the requirements of nearly every motor manufacturer. In this table he could also take a 2-H. P. motor with maximum speed 1,800 revolutions. With this he could get a 4 to 1 speed variation, 3 to 1, 2 to 1, and 1½ to 1, with maximum speed of 1,800, 1,200, or 900 for a 2 to 1 motor. This is also sufficiently large to meet nearly all requirements."

A paper entitled "The Creation of Machinists" presented anonymously was interesting to the majority of the members of the association inasmuch as it outlined a plan that has been successfully followed by a machine tool builder in Ohio in training young men to become skilled in the operation of machine tools under conditions that differ materially from those ordinarily surrounding the education of apprentices. In an address on the same subject made by E. P. Bullard, Jr., he referred to his experiences with the partial apprenticeship system successfully used in his company, the Bullard Machine Tool Co., for training men of mature years to become skilled machine men. The following papers were also presented:

"Industrial Education—A Source of Supply Increasing the Efficiency of Machinists," by Mr. F. A. Geier, who described the Cincinnati plan, and M. A. Coolidge on the Fitchburg plan. (See another part of this issue for the text of each.) Dr. W. H. Tolman, director of the Museum of Safety and Sanitation, New York, gave his famous stereopticon lecture "The Perils of Peace, or a Safer America." Dr. Tolman's remarks and views strongly impressed the machine tool builders, and when it became known that he had an itinerary that covered the manufacturing districts of the Middle West, arrangements were made by a number of the western leading machine tool builders to accord him a hearty welcome. The concluding paper delivered on the afternoon of Wednesday was "Reinforced Concrete Construction from the Machine Tool Industry Standpoint," by J. P. H. Perry. This paper was illustrated with stereopticon views showing the features of construction details of interest to those contemplating the use of concrete for manufacturing structures.

The following officers were elected: President, F. A. Geier, Cincinnati, Ohio; 1st vice-president, Fred L. Eberhardt, Newark, N. J.; 2nd vice-president, P. E. Montanus, Springfield, Ohio; treasurer, George W. Fifield, Lowell, Mass.; secretary, Charles E. Hildreth, Worcester, Mass. Rochester, N. Y., was chosen as the meeting place for the spring convention next year.

MACHINERY'S SEVENTH ANNUAL OUTING

Following the convention of the National Machine Tool Builders' Association in New York, MACHINERY gave its annual outing October 14 to nearly 500 invited representatives of the machine tool trade and closely allied industries. The steamer *Sagamore*, chartered for the day, was loaded with eatables, drinkables and "smokables" appropriate for the occasion. The party met at the Battery shortly before noon, and with some misgivings on the part of those inclined to be seasick, the steamer started on a course south by southeast through the choppy waters of the upper bay, Narrows and lower bay. After a somewhat windy trip Sandy Hook was sighted and taken by assault, notwithstanding the presence on the dock of Col. Rogers Birnie of the Ordnance Department of the Sandy Hook Proving Ground, Col. H. L. Harris, of the Coast Artillery Corps, and other officers. Yielding gracefully to the inevitable, the officers guided the invading host through a well-equipped machine shop, where the weapons of war are repaired and supplied with missing members, to the proof battery where the big and little machine tool builders were finally gathered together and photographed *en masse* with the result noted in the accompanying illustrations—but "the worst was yet to come."

The party was ordered to climb up on the five concrete parapets back of the proof battery where the big guns are tested, see Fig. 2, and after being cautioned to stop their ears when the whistle sounded, a 12-inch gun was fired with 270 pounds of nitro-cellulose powder. The 12-inch shell was hurled through two sets of vertical wires about 100 feet apart, comprising part of the Le Boulenge chronograph apparatus used for determining the velocity, and far out to sea, where it was seen to ricochet twice before disappearing. Adequate description of the sight and the sensation produced is quite impossible; it must be seen and felt to be appreciated. Following the firing of the 12-inch gun came the firing of a 6-inch gun mounted on a 6-inch disappearing carriage. Two rounds of shrapnel were followed by one common 7-inch steel shell filled with explosive "D" fired into a sand parapet about 500 yards from the proof battery.

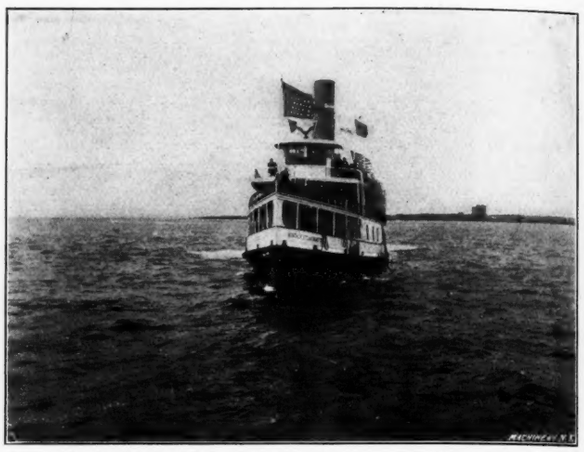


Fig. 1. MACHINERY'S Steamer "Sagamore" approaching Sandy Hook

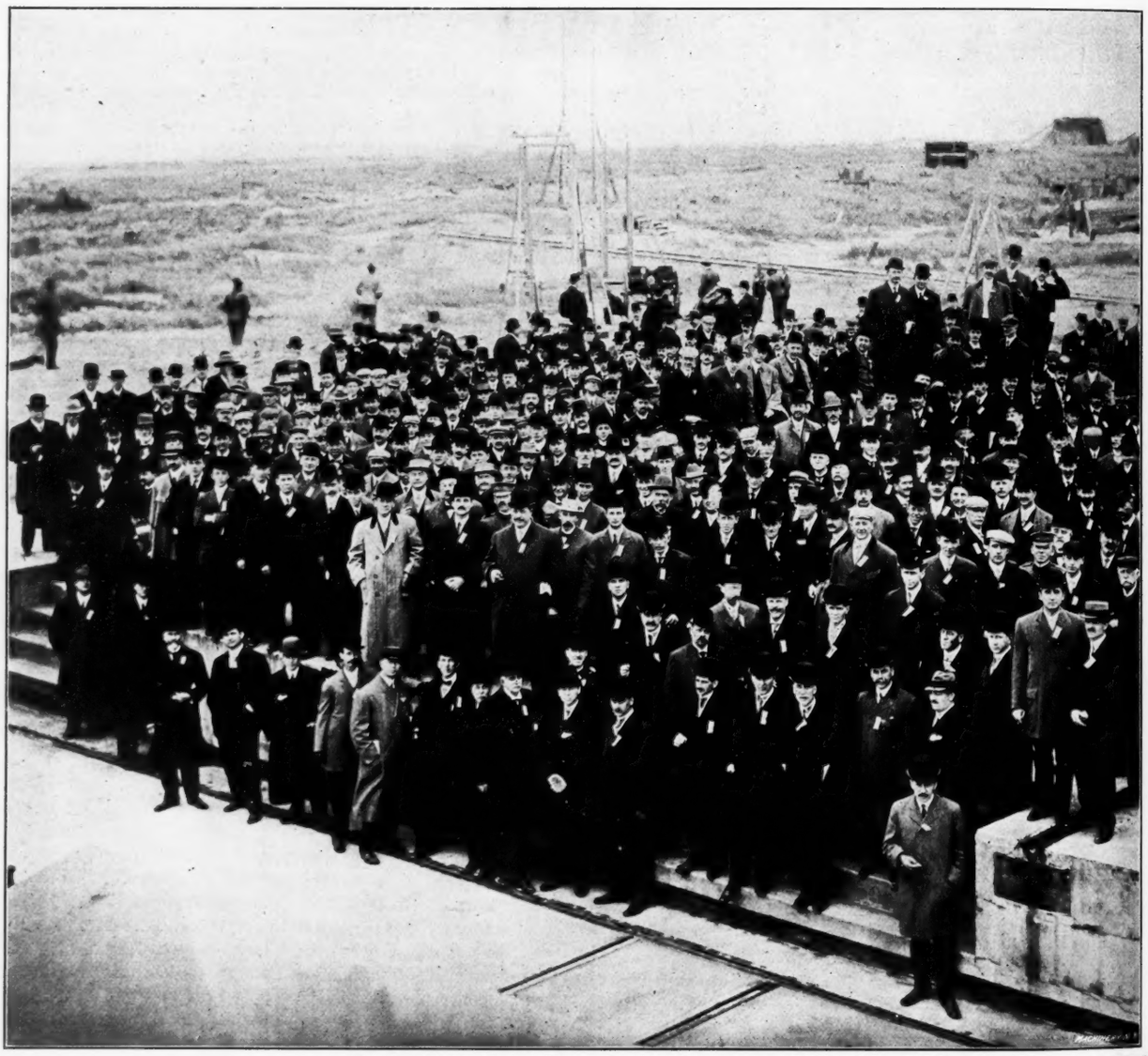


Fig. 3. Machine Tool Builders, Members of the Machine Tool Trade on MACHINERY'S Outing, October 14

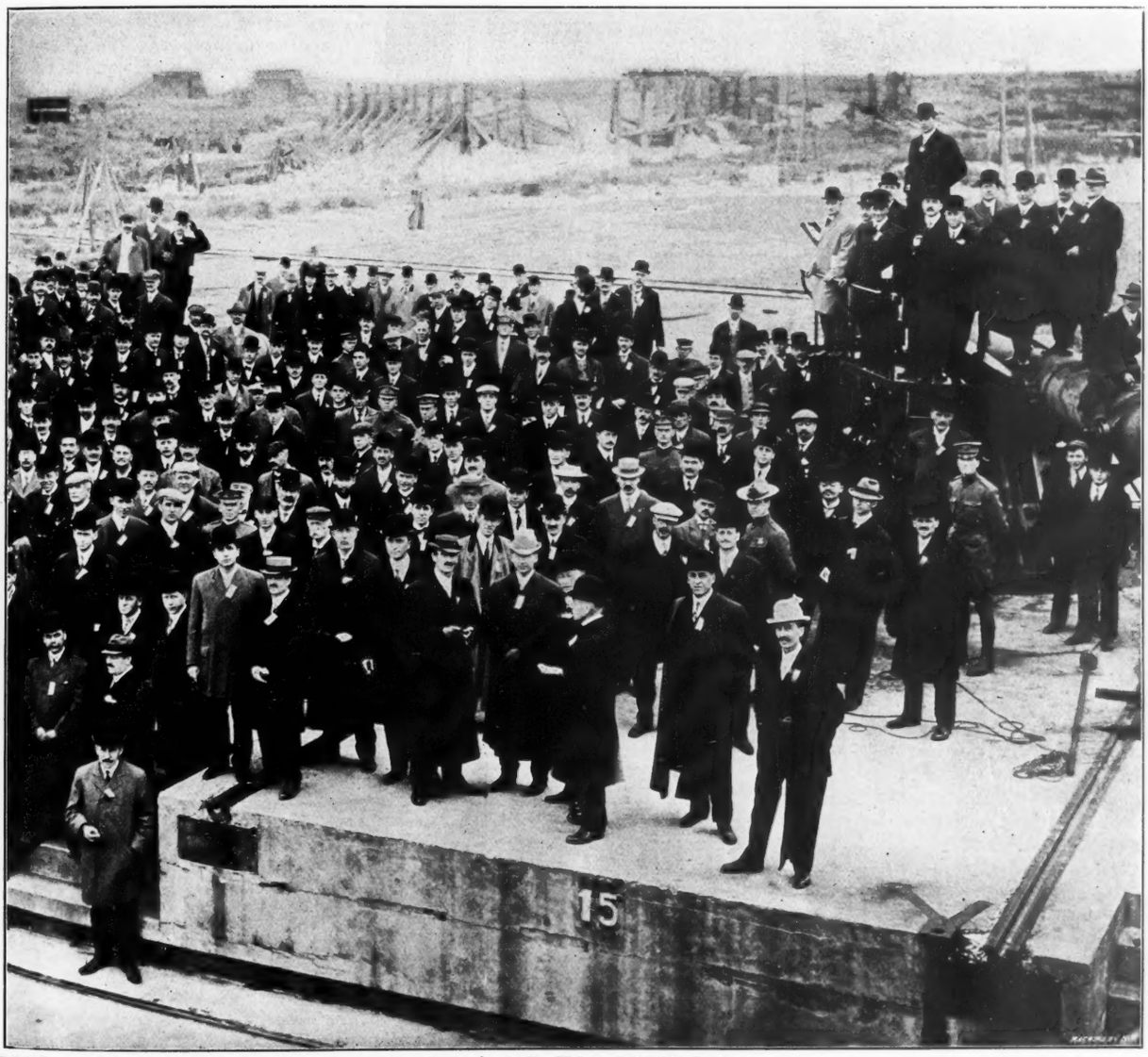
The party of visitors then divided into two groups, one

taking the train on the Sandy Hook R. R., the only railroad owned by the U. S. Government, to the spot where the 16-inch gun is located, while the other party inspected the fortification known as Battery Richardson and mortar battery, Battery Granger, and each party in turn visited the objects of interest

Fig. 2. Machine Tool Builders watching the Firing of Big Guns at Sandy Hook Proof Battery from the Concrete Parapets in the Rear

The inspection of the 16-inch gun under the direction of Col. Birnie was made enjoyable especially by his interesting account of the history and construction of the gun, with some remarks on the experiments made with the Gathmann gun, on a nearby armor plate and with a regular 12-inch gun on 5- and 6-inch armor fitted to a section of a battleship's hull. The 16-inch gun, which is the largest in the world, firing a projectile weighing 2,370 pounds with a velocity of 2,300 feet per second, has been discharged about fifteen times. No duplicate has been built and none is likely to be made because the great weight of the gun makes manual operation practically impossible. (See MACHINERY, December, 1903.) The lighter 12-inch, and the 14-inch guns recently authorized can, if necessary, be operated by hand, which is a great advantage, as defects in the operating machinery are likely to develop when the total disability of a gun might mean great disaster. The fortifications, Battery Richardson and Battery Potter, facing the main channel, are built of monolithic concrete behind a bank of sand and are practically invisible from the sea. The guns are mounted on disappearing carriages, and beneath the barbettes are ammunition rooms in which shells and powder are stored. Automatic hoists, driven by electric motors, convey the ammunition to the guns when in action.

The party returned to the Battery about 5:45 o'clock after having spent the afternoon on the desolate strip of sandy land



grouped on the Proof Battery, Sandy Hook. Picture taken just prior to the Firing of the Big Guns

seen by the other. Opportunity was given to a limited number to inspect the workings of the range-finding towers in which the positions and distances of vessels miles out at sea are accurately determined, and from which the angles of elevation are telephoned to the batteries.

near New York that is frequently mentioned in the public press, but on which very few Americans have ever set their feet, it being a government reservation to which admittance is usually denied. The fortifications, of which only a fraction were inspected, are said to be the strongest in the world.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

THE BRYANT CHUCKING GRINDER

A great many interesting machine tools built in the small machine tool manufacturing towns in Vermont have from time to time been illustrated and described in MACHINERY. The latest interesting machine brought out by the machine tool builders in this state, is the Bryant chucking grinder, built by the Bryant Chucking Grinder Co., of Springfield, Vt. The inventor of this machine is Mr. W. L. Bryant, for eight years chief draftsman of the Jones & Lamson Machine Co., of the same town. Its purpose, though perhaps not the full intent of its field, is indicated by its name. The ingenious features of its construction and mechanism will be made manifest as the description proceeds.

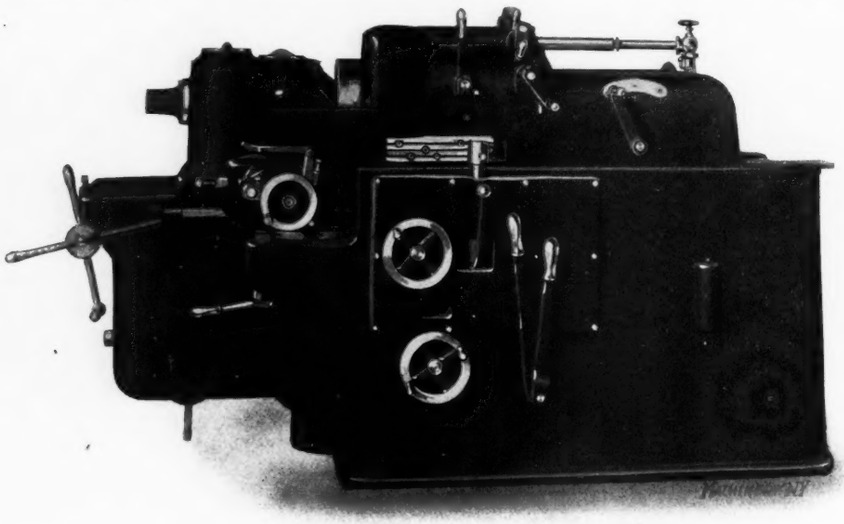


Fig. 1. The Bryant Chucking Grinder, for completing Several Grinding Operations at One Setting

General Description

Briefly, this machine is intended for work held in the chuck, and on such work presents the advantages, first of a number of wheels, constantly set, and each of suitable grain, grade, shape and surface speed for its work; second, of a number of convenient stops, for both longitudinal and cross adjustments, making the accurate duplication of lengths, thicknesses and diameters an easy matter; thus permitting, also, the performing of several operations at one chucking; and, finally, it offers those conveniences of feed and speed change, adjustment and control which make the turret lathe such a profitable investment in a well-managed machine shop.

The general design of the tool will be understood best from a study of Figs. 1 to 4, inclusive. The bed of the machine is a massive casting, *A*, of rigid box form. On its upper surface it is provided with one V and one flat way, on which slides the wheel-carrying head, *B*, carrying three spindles, any one of which may be adjusted outward to permit its wheel to operate on the work without interference from the other two. To the left of the main bed in Figs. 1, 3 and 4, is swiveled the bracket *C*, about the vertical axis of pivot *E*. The angle is read by a graduated circle, and the swivel is brought back to parallel position against a positive stop. Lever L_2 binds this adjustment. This bracket *C*, in turn, supports the work spindle head *D*; the swiveling about the axis of *E* thus gives provision for grinding tapers. A longitudinal adjustment of the head on the bracket, by pilot wheel E_2, against any one of three adjustable stops, permits a change of adjustment to agree with the length of the work projecting from the chuck; a cross adjustment at this point gives control of diameters, and feeds the work across the cup wheel for facing cuts. This cross feed is operated automatically from the power traverse of the wheel spindle head. Having thus briefly described the structure of the tool, we are prepared for a detailed description.

The Wheel and Work-driving Mechanism

The whole machine is driven from a constant speed pulley *F*. No complicated overhead works are required, the machine may be located without strict reference to the countershaft space, and the motor-driving problem is reduced to its simplest terms.

Pulley *F* is keyed to shaft *G*, which, in turn, is keyed to drum *H*. Over the latter passes a belt which runs over a series of tight and loose pulleys (see *J* and J_1) on the wheel spindle driving shafts. These are so arranged that the shifting of the driving belt connecting drum *H* with pulleys *J*, J_1, etc., transmits the power to either the rear, or facing wheel, the center or internal wheel, or the front or external wheel. Lever *K* and belt shifter *L* control the driving belt for this purpose. Drum *H* and shaft *G* are mounted in a swing cradle, to keep the driving belt tight. The adjustment for this cradle is shown at *M* in Fig. 3. It should be noted that the driving belt does not pass directly over the pulleys on internal spindle *N*. Instead, the pulleys on this spindle are driven at an increased speed from pulley Z_1 on the idler shaft. The central position of lever *K* normally stops all the wheel spindles, but by the operation of lever *O*, the internal wheel may be started or stopped.

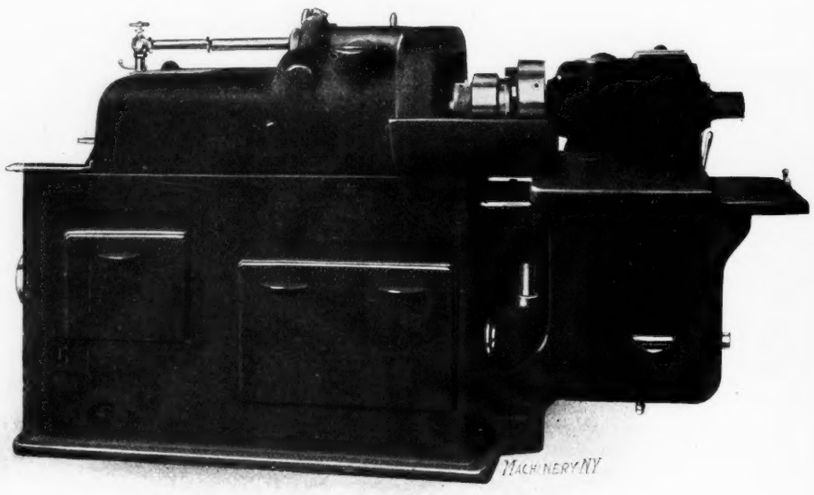


Fig. 2. Rear View of Grinder, showing Massive Construction

Levers *P*, P_1 and P_2 are connected with the wheel spindle quills by a rack and pinion movement, which allows them

to be projected or withdrawn, as required for clearance. These levers are provided with positive adjustable stops for this movement, permitting the duplication of the adjustments on each successive piece of work. Lever Q binds or loosens all the quills simultaneously, for making this adjustment.

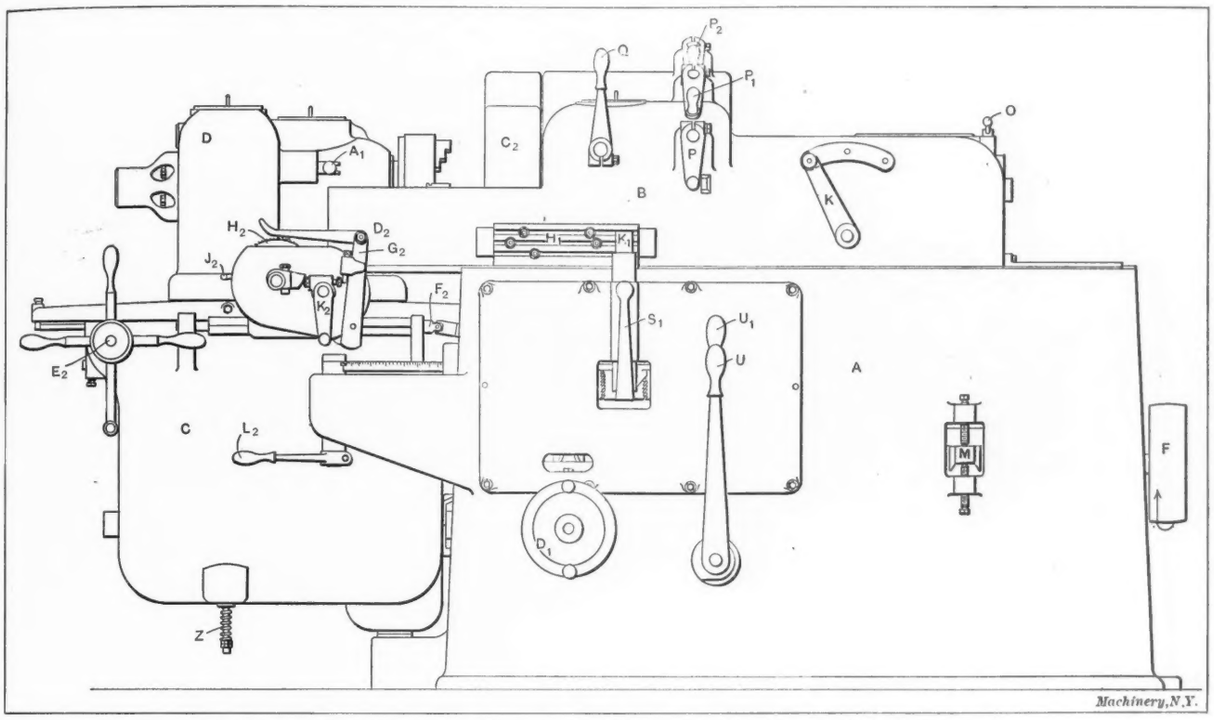


Fig. 3. Front Elevation, showing Arrangement of Slides, Controlling Levers and Hand-wheels, etc.

Shaft G, see Fig. 4, carries also a small pulley R for driving the usual water pump, and also the pinion S, which meshes with the driving gear for the work speed changing mechanism. This latter is mounted as a unit in an oil bath casing, and is of the double clutch, silent ratchet type made familiar in the spindle drive of the Hartness flat turret lathe. It is incompletely shown at T, in Fig. 4. The nine changes of speed are controlled by the two levers U and U_1.

From the speed box, the motion is transmitted to shaft V in swiveling bracket C, through the angular bevel gear drive at W, about the axis of E. About shaft V is pivoted a yoke, in which is journaled a drum, connected by spur gearing with shaft V. From this drum a belt passes around idler X, and over driving pulley Y on the work spindle. A spring Z (see Fig. 3) keeps the drum in the swinging yoke drawn down, so the belt is always taut. Lever A_1 controls a reversing mechanism for the work spindle, operating through shaft B_1, and the connecting gearing shown. This is employed for certain cases in which the rear or facing wheel spindle is used for cylindrical or internal surfaces. The same lever A_1 is used for stopping the work spindle, and is connected with a brake for doing this expeditiously.

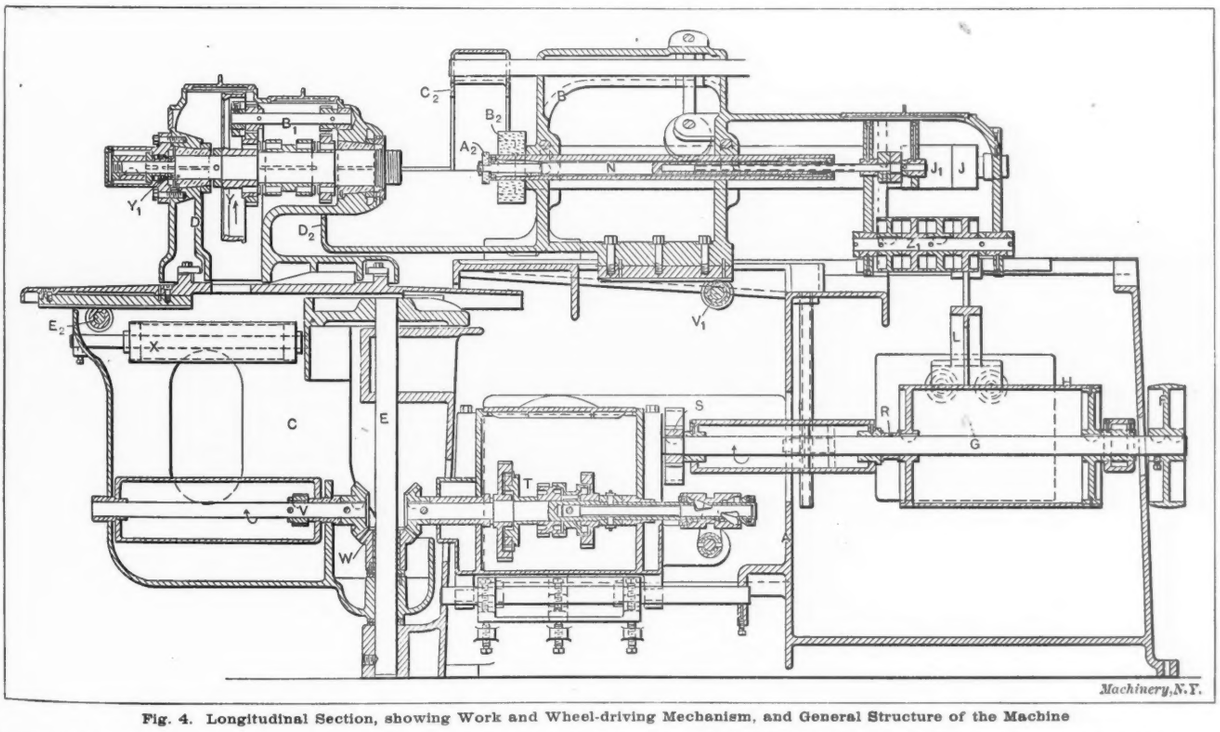


Fig. 4. Longitudinal Section, showing Work and Wheel-driving Mechanism, and General Structure of the Machine

The Longitudinal and Cross-feed Mechanisms

The variable feed mechanism for operating the traverse of the wheel spindle head is best seen in Fig. 5. It is connected by a train of gears with the driven shaft of the work speed change mechanism, so that the linear feed of the wheel per

revolution of the work is not affected by changes in work speed. The variation in feed is obtained by the Hartness modification of the Sellers friction disks, in which a very slight swing of the female disks changes the point of contact so rapidly as to effect a great change in the feed. The male or driven disk is shown at C_1, in Fig. 5. The change of feed is effected by a cam connected with hand wheel D_1 in Fig. 3.

Disk C_1 is connected with shaft E_1 by a bevel gear reverse F_1, controlled by the clutches at G_1. At H_1, on the side of the wheel spindle slide are cut three T-slots, in which are clamped

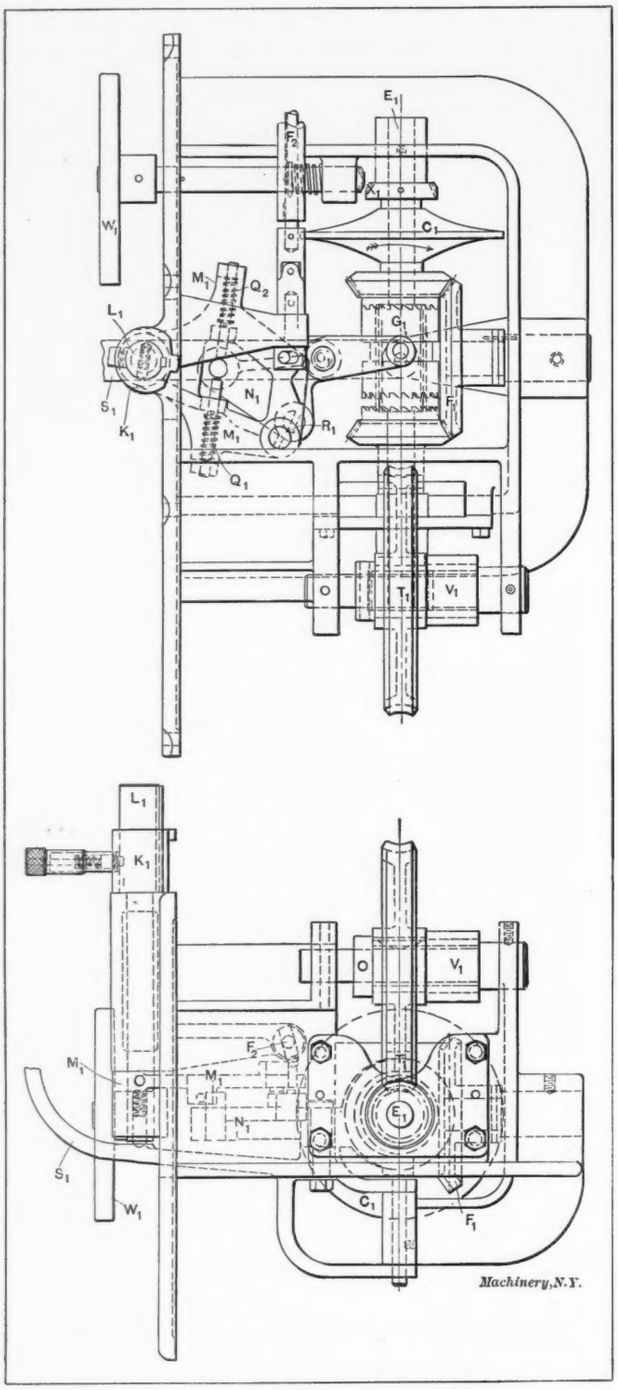


Fig. 5. The Wheel Head Traverse Mechanism

three sets of automatic reverse dogs, one for each wheel. These dogs strike a projection on collar K_1, which may be raised or lowered on rock shaft L_1 to line with the set of dogs it is desired to use. To L_1 is keyed the sector M_1, which is one member of a "load and fire" mechanism for controlling clutch G_1; its purpose is to prevent the clutch from stopping on dead center. It is the simplest in construction of any mechanism of this kind the writer remembers having seen.

Clutch G_1 is shifted to the right or left by a fork and sector N_1, pivoted at O_1. In the position shown, when sector M_1 is swung to the left by the reversing dogs, spring Q_1 is thereby compressed against a pin in sector N_1 tending to throw it to the left, and thus throw the clutch G_1 to the right, reversing the movement. This is prevented for the time being, however, by the interference of the ledges milled in the faces of the pins at R_1, one of these being fast in sector M_1 and the other in N_1. When M_1 has been turned so far to the left, however, that spring Q_1 is properly compressed, these pins snap by each other on the further side, allowing the clutch to be thrown.

Going in the opposite direction, this process is reversed. The dog at H_1 swings sector M_1 to the right, compressing spring Q_1 against the pin in N_1. The swinging of the latter under this spring pressure is resisted as before by the pins R_1, which finally snap by at the end of the movement. The pivot O_1 of segment N_1 is mounted in lever S_1, which thus furnishes means for stopping and starting the traverse movement at any point in the travel, independently of the automatic reverse.

The motion from the reverse clutch at G_1 is transmitted to the wheel spindle head through worm gearing at T_1 and a

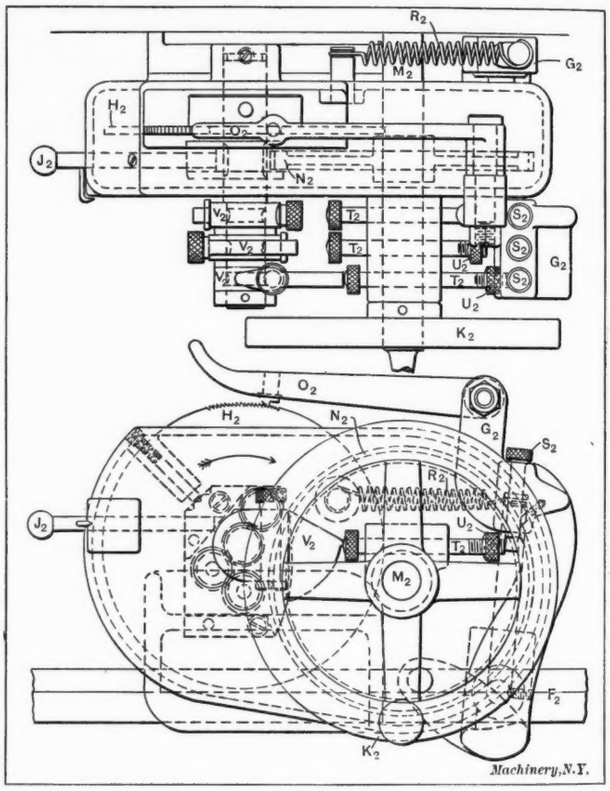


Fig. 6. The Cross-feed Mechanism, with Automatic Diminishing Device and Stop

pinion at V_1, which engages the rack under the slide. Fine hand adjustment for facing, etc., is effected when the power feed is thrown out, by hand wheel W_1, through bevel gears at X_1. This hand wheel is shown in Figs. 1 and 5, but not in Fig. 3, the latter being incomplete in this respect. When not in use, it is withdrawn until bevel gears X_1 are out of engagement, and the wheel is free.

A telescopic shaft, F_2, leads from the automatic traverse mechanism on the main base of the machine, to the cross feed mechanism for the work spindle head on the swiveling bracket. This shaft is rocked at each end of the stroke by a cam surface on sector M_1, which is, as we have seen, controlled by the reversing dogs at H_1. The telescopic shaft transmits this movement properly at whatever angle the swiveling bracket and work spindle may be set.

The cross feed screw M_2 (see Fig. 6) has mounted on it a hand wheel K_2 (a crank is shown in Fig. 3) and a spur gear N_2. This latter is connected with ratchet wheel H_2 by a tumbler gear arrangement, controlled by lever J_2, which thus provides for reversing and throwing out the feeds. The

ratchet wheel is operated by a pawl O_2, pivoted to lever G_2, which in turn receives its movement from rock shaft F_2 shown in Figs. 3 and 5. This movement is positive in the direction which operates the ratchet wheel H_2, and through it the cross feed. In the other direction it is drawn back by spring R_2 until the point of plunger S_2 brings up against the adjustable stop T_2. As the position of T_2 allows a greater or less amplitude of movement to the swinging of lever G_2, a greater or less cross feed is effected at each stroke.

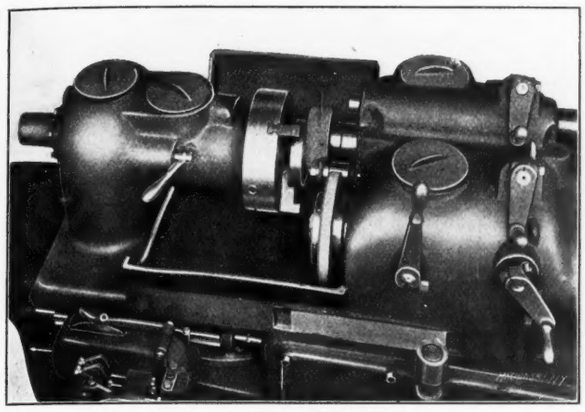


Fig. 7. The Facing Wheel in Use

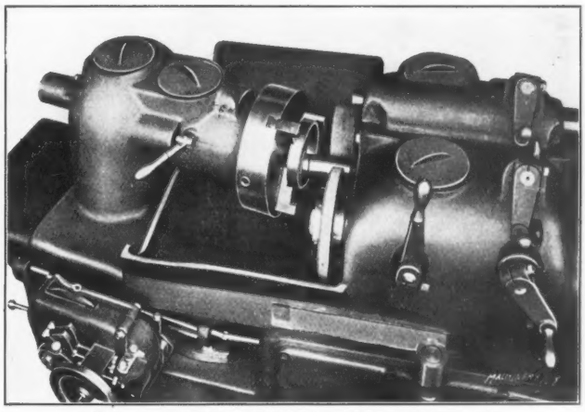


Fig. 8. The Work Head Swivelled for Taper Work

The position of stop T_2, and the consequent amount of feed, is governed by two things. In the first place, the knurled nut U_2 furnishes a check to its backward movement, and thus regulates the rate of cross feed. Screwing this nut out increases the feed—screwing it back decreases it. In the second place, the feed is controlled by cam V_2, which is adjustably clamped on the shaft of ratchet wheel H_2, and revolves with it in the direction of the arrow. As the feeding progresses, the lower edge of V_2 comes into contact with the left-hand end of stop T_2, gradually limiting its movement from that permitted by the adjustment of U_2 until finally, in the position shown, the swinging of lever G_2 is stopped altogether, thus stopping the cross feed. The diminishing depth of cut thus provided for, as the desired finished diameter is approached, gives the best results obtainable from the standpoints of accuracy and finish.

It will be noted in the top view in Fig. 6 that there are three each of stop cams V_2, stops T_2, feed adjusting nuts U_2 and plungers S_2. Any one of these three latter may be pressed down into working position, thus giving a separate cross feed stop and rate of feed for each of three operations.

Salient Points in the Design

The reader might perhaps be pardoned for skipping the detailed description of the mechanism just given. It is made necessary by the fact that the machine is new from "the ground up," so it has to be described in the same way, there being no similar machine with which mental comparisons may be made. The reader, however, should not fail to examine certain noteworthy features of the design which are of universal interest, being applicable to machines of other types, made for other purposes.

One of the points of interest in the machine is its strength and rigidity. This is rather unusual in the matter of weight alone, which is about 4,200 pounds. Rigidity has been secured by very careful design. This might not seem to be important in a grinding machine, where the strains are light as compared with machines of the lathe and miller type. If there are no heavy strains to contend with, however, there is liable to be enough of vibration to cause serious trouble, and weight and stiffness are needed to counteract this.

In the matter of rigidity, note first the heavy box-like form of the main castings. This form also serves, of course,

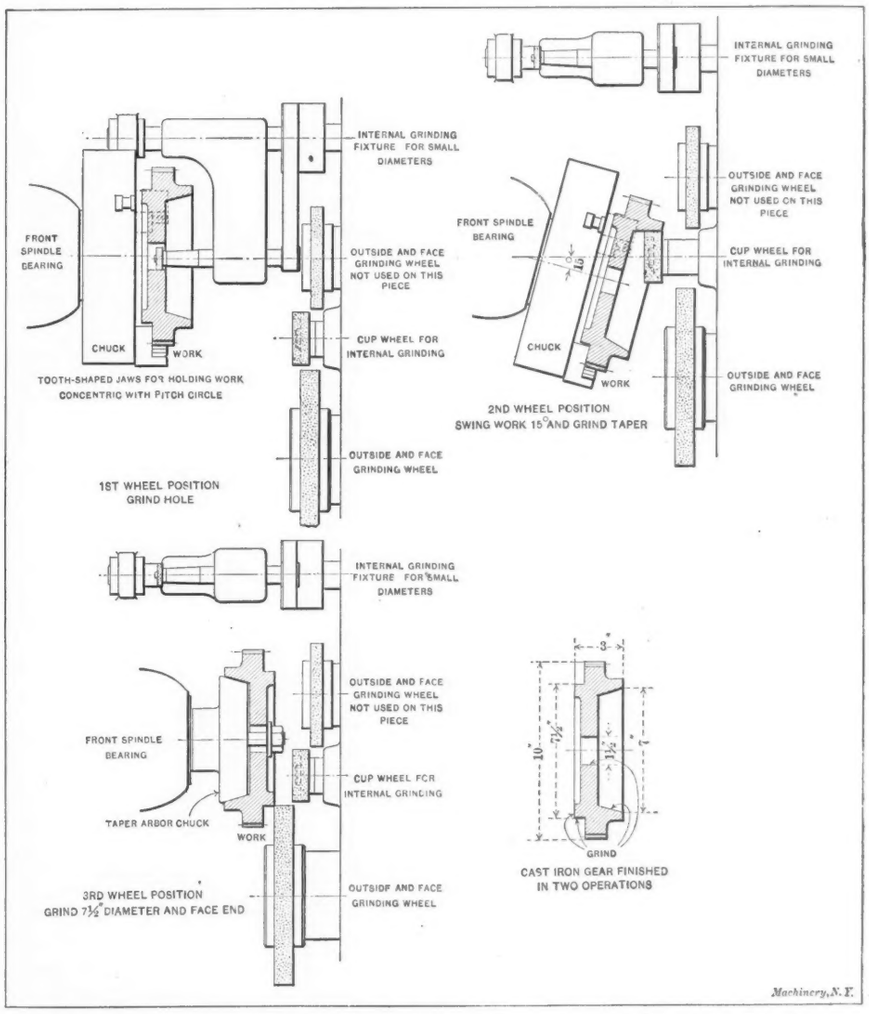

INTERNAL GRINDING FIXTURE FOR SMALL DIAMETERS
FRONT SPINDLE BEARING
OUTSIDE AND FACE GRINDING WHEEL NOT USED ON THIS PIECE
CUP WHEEL FOR INTERNAL GRINDING
CHUCK
WORK
OUTSIDE AND FACE GRINDING WHEEL
TOOTH-SHAPED JAWS FOR HOLDING WORK CONCENTRIC WITH PITCH CIRCLE
1ST WHEEL POSITION GRIND HOLE
15°
2ND WHEEL POSITION SWING WORK 15° AND GRIND TAPER
TAPER ARBOR CHUCK
3RD WHEEL POSITION GRIND 7½" DIAMETER AND FACE END
3"
10"
7½"
3½"
7"
GRIND
CAST IRON GEAR FINISHED IN TWO OPERATIONS
Machinery, N. Y.

Fig. 9. Diagram showing the Method of Finishing a Hardened Gear with Conical Clutch Surface

to protect the mechanism from emery dust and other grit. Then again, the solid, long bearing of the swivel adjustment should be compared with that found on the ordinary design of universal grinder. All unnecessary sliding surfaces are

avoided, and the connection between the work and the wheel, through the main castings, is strong and direct, there being a notable absence of built-up constructions.

An interesting point, along this line, should be noticed. The work spindle head slides crossways on a thin platen, which, in turn, slides longitudinally on the top of swinging bracket *C*. This platen at first sight appears to be an example of the built-up construction which the designer tried to avoid. This is not the case, however. It is thin and flexible, receiving its stiffness from the head and bracket to which it is gibbed. Furthermore, the gibbing points for this platen on the upper member are directly over those for the lower member, so that strains are transmitted in direct tension and compression, with no possibility of the deflection strains (even in this thin platen) which usually "raise hob" with rigidity.

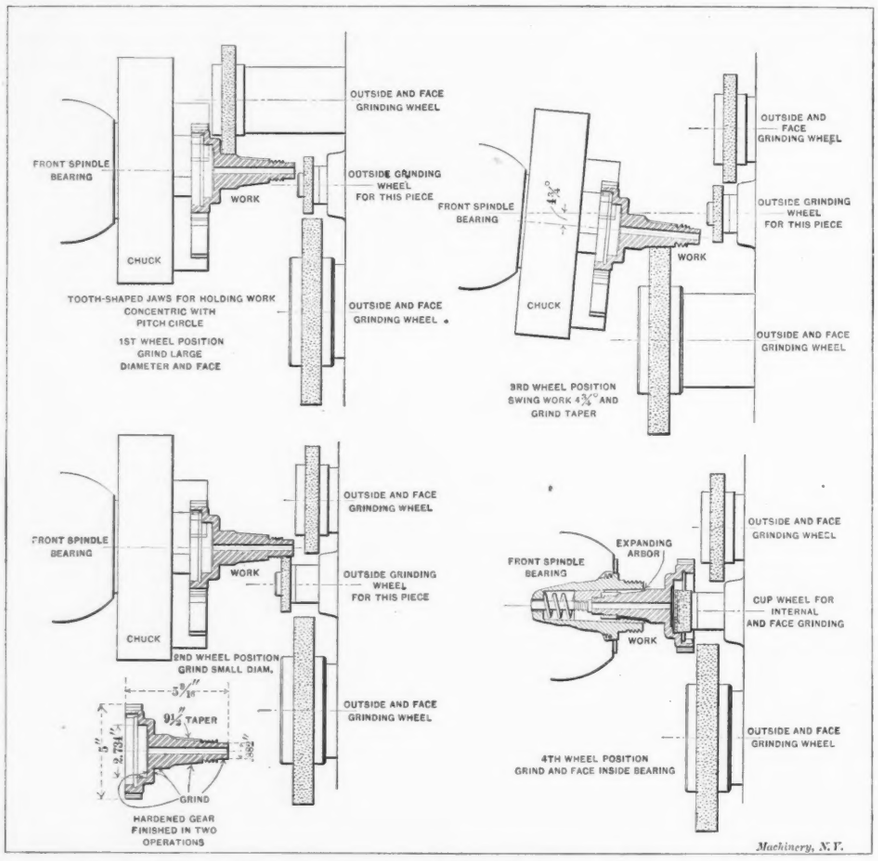

OUTSIDE AND FACE GRINDING WHEEL
FRONT SPINDLE BEARING
OUTSIDE GRINDING WHEEL FOR THIS PIECE
WORK
CHUCK
TOOTH-SHAPED JAWS FOR HOLDING WORK CONCENTRIC WITH PITCH CIRCLE
1ST WHEEL POSITION GRIND LARGE DIAMETER AND FACE
OUTSIDE AND FACE GRINDING WHEEL
OUTSIDE AND FACE GRINDING WHEEL
FRONT SPINDLE BEARING
OUTSIDE GRINDING WHEEL FOR THIS PIECE
WORK
CHUCK
OUTSIDE AND FACE GRINDING WHEEL
3RD WHEEL POSITION SWING WORK 4 3/8" AND GRIND TAPER
OUTSIDE AND FACE GRINDING WHEEL
FRONT SPINDLE BEARING
WORK
OUTSIDE GRINDING WHEEL FOR THIS PIECE
CHUCK
2ND WHEEL POSITION GRIND SMALL DIAM.
OUTSIDE AND FACE GRINDING WHEEL
3 9/16"
9 1/2° TAPER
2.724"
5"
GRIND
HARDENED GEAR FINISHED IN TWO OPERATIONS
OUTSIDE AND FACE GRINDING WHEEL
EXPANDING ARBOR
FRONT SPINDLE BEARING
CUP WHEEL FOR INTERNAL AND FACE GRINDING
WORK
OUTSIDE AND FACE GRINDING WHEEL
4TH WHEEL POSITION GRIND AND FACE INSIDE BEARING
Machinery, N.Y.

Fig. 10. Method of Finishing a Piece requiring Two Settings, and having Cylindrical, Face and Taper Surfaces to be ground

Criticism might perhaps be directed toward the large overhang of the work spindle. This is given to permit the entrance of guard D_2, to catch the water and dust. This overhang is apparent only, however, as the base of the head is extended to a long bearing out under the working point. It is similar in this respect to the spindle heads used on the Beaman & Smith duplex cylinder boring machines, having the advantage, however, of having the head and extended slide one solid casting, instead of being bolted together, as is necessary in the other case.

Another point shown, though not very plainly, in Fig. 4 at Y_1, is a device used for taking up the end movement of the work spindle. This is very necessary in accurate face plate and chuck work, whether in the lathe or grinding machine, as every good mechanic knows. It is not possible to do it well enough or to do it permanently by adjusting the take-up for the thrust bearing. It is therefore common practice, wherever possible, to put a stick against the center of the work, and bring the tail center up against it, thus taking out the slack. This machine has the stick incorporated in it. Springs at Y_1 are always in action, forcing the spindle up to a firm bearing on the end thrust.

Typical Operations

In Figs. 9 and 10 are shown diagrams which illustrate the use of the machine quite clearly. The first of the parts, in Fig. 9, is a cast iron gear with a conical clutch surface. This has to be ground, as shown, in the bore, the clutch surface, and on one face and outside diameter. In the first operation the work is held by tooth-shaped jaws which hold it concentric with the pitch line. Here the bore is ground with a supplementary internal attachment, as shown, provided for work having small holes. (This supplementary spindle may also be used for buffing and polishing with rouge and a soft wheel.) In the second wheel position the work spindle and the bracket on which it is mounted are swiveled to the angle of the conical surface 15 degrees, as shown, which is finished with the regular internal wheel. For the second operation and third wheel position (which finishes this piece) the work is held by its finished clutch surface on a taper arbor mounted in the work spindle. This arbor may be ground in place to insure absolute accuracy.

The piece of work shown in Fig. 10 is also a gear, but of much more complicated form. It is made of hardened steel. For the first operation (including the first three wheel settings) it is held in gear-tooth chuck jaws the same as in the case shown in Fig. 9. In this first operation all three of the regular wheels are used, all on external surfaces. First the large bearing is ground with the rear wheel, then the small outer bearing is ground with the central wheel, and finally, in the third position, the 9½-degree taper is finished with the outside wheel. This operation shows quite plainly that only a small lateral adjustment of the work spindle is required for the different positions. This will be seen by comparing the center lines of the work and of the central wheel spindle in each case. This is due to the fact that the three wheel spindles are located in this natural position, and to the fact that the swiveling adjustment for taper grinding is about an axis which approximately passes through the point of contact of the wheel and work.

In the fourth wheel position and the second operation, the work is held on the conical shank by a special expanding chuck, made to fit it. For this operation the middle or internal wheel only is used, this being employed for both the grinding of the hole and the facing of its internal seat.

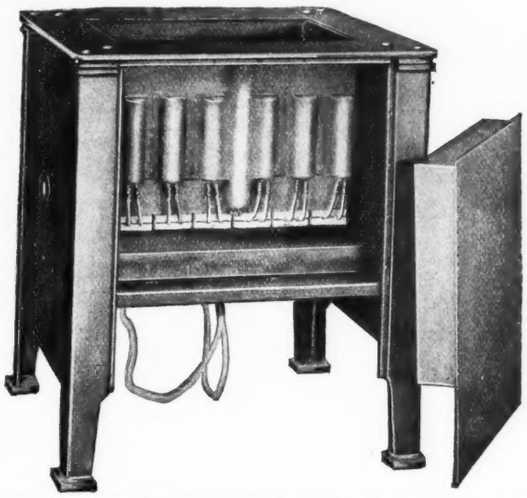
The Field of this Grinding Machine

These two examples will serve to show the convenience and time-saving qualities of this design of grinder, with its three (or four) wheels permanently mounted in place, its variety of adjustments, and its conveniently controlled stops, feeds, speeds, etc., for each operation.

It will readily be seen that this chucking grinder bears the same relation to the standard universal grinding machine, that the turret lathe on chuck work does to the standard engine lathe. Its field is thus a large one, though its particular adaptability to automobile work will be at once recognized. It is entirely conceivable that it may open up a new field of its own, in finishing certain parts from rough turned, or even rough castings and forgings. Mechanics will readily recognize its advantages, as a labor- and time-saving machine, and being, as it is, radically new in its design, it will undoubtedly create considerable interest among machine users.

ELECTRICALLY-HEATED OIL TEMPERING BATH

The accompanying illustration shows an electrically-heated oil tempering bath manufactured by the General Electric Co., Schenectady, N. Y. The bath is contained in a cast iron tank or pot, having 12 lugs evenly spaced around the sides. These lugs are drilled to receive standard cartridge units, and by thus distributing the units an even temperature can be maintained



Electrically-heated Oil Tempering Bath, made by the General Electric Co., Schenectady, N. Y., showing Removable Cartridge Units

in all parts of the oil. Around the pot is placed a heat retaining jacket, consisting of an inner and outer wall of sheet metal, the space of three inches between the walls being filled with mineral wool. The jacketing on the back side of the tank is easily removed, thus allowing quick access to the internal connections of the units. Around the top of the tank a wide flange is provided, to which four cast iron legs are screwed. A drain pipe controlled by a globe valve provides a means for drawing off the oil. A protected recess is provided in one end of the tank in which a thermometer may be placed for indicating the temperature of the oil bath.

Two methods are in vogue for using the oil bath. In the first method the temperature of the oil is raised to 250 degrees F., and then the work is placed in the bath and the full current turned on. When the oil reaches the desired temperature, the work is removed and the current turned off. The second method is to turn on the full heat at once, and bring the oil to the required temperature, and then to introduce the work, and by means of regulating switches, maintain the temperature constant for any required length of time.

A cast iron basket or tray may be supplied in which the work can be placed. This basket has eye-bolts at each end to facilitate its handling, and the bottom is perforated with 7/8-inch holes to permit free circulation of the oil. Short legs are provided on the bottom of the basket which keep the work about an inch above the bottom of the bath.

Any desired temperature is obtained by throwing in the necessary number of units to give the approximate heat. Close regulation is then secured by varying the voltage on one of the units by means of a rheostat. Three sizes of tempering baths are made, the smallest having a capacity of nine gallons of oil, the medium size, of 11 gallons, and the largest, of 37 gallons, the first requiring 6 K. W. per hour, the medium, 7.2, and the largest size, 20 K. W. for its operation. This energy consumption is sufficient to heat the oil to a temperature of 450 degrees F. in less than one hour, when starting cold. The lengths of the three sizes are 22, 18, and 30 inches, respectively; the widths, 12, 12, and 16 inches, and the depths, 8, 12 and 18 inches. The smallest oil bath weighs 420, the medium, 475, and the largest, 900 pounds.

CINCINNATI-BICKFORD 20-INCH GANG DRILL

The accompanying illustrations Figs. 1 and 2 show front and rear views, respectively, of a new arrangement of 20-inch sliding head drills operating in gang, and manufactured by the Cincinnati-Bickford Tool Co., Cincinnati, O. As shown in the illustrations, four individual drills, each fitted with power feed, automatic stop, and quick return, have been placed on a common base pedestal. The rear view, Fig. 2, shows the driving arrangement, transmitting the power through a continuous shaft provided with clutches, admitting of the throwing in and out of any one drill at any time. The continuous shaft is provided with a tight and loose pulley at one end, as shown. The lever for operating the clutches by means of which each spindle can be stopped independently, is bent over towards the front, so that the operator at the front of the machine can conveniently reach it.

These drill presses are provided with sliding heads and the table has also a sliding movement as shown in Fig. 1, so that it can be operated up and down by means of a crank on ways planed on the face of the column, giving the table a rigid support and bearings at points far apart. The arrangement of sliding heads in combination with a vertically movable table gives the machine a considerable range for handling pieces of comparatively large proportions. The table is continuous across the whole front of the machine as shown, and is provided with two T-slots. The sliding heads are balanced

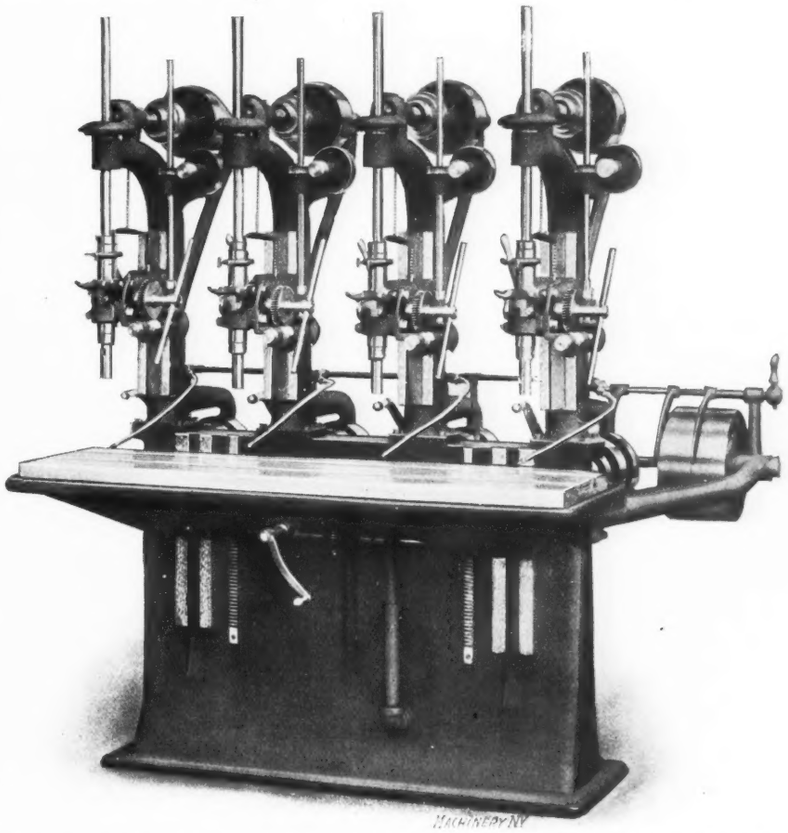


Fig. 1. Twenty-inch High-speed Gang Drill, built by the Cincinnati-Bickford Tool Co., Cincinnati, O.

and can be quickly adjusted and tightened. The spindles are provided with ball thrust bearings, and with steel jam nuts, which minimize the friction and afford adjustment for taking up the wear, when necessary. The sleeves, shafts and spindles are finished by grinding.

Three power feeds are provided for the spindle, the power feed being operated through pulleys, worm and bevel gearing.

The worm operating the worm-wheel on the pinion shaft in the head revolves in an oil bath contained in the worm casing, thus insuring long life to the worm gearing. All the bevel gears are planed so as to provide proper contact between the teeth and silent running. Proper guards are provided for all exposed gearing. The spindle sleeve is graduated, and on the power feed machines provided with automatic trip, this graduation affords a means for setting accurately the automatic trip collar.

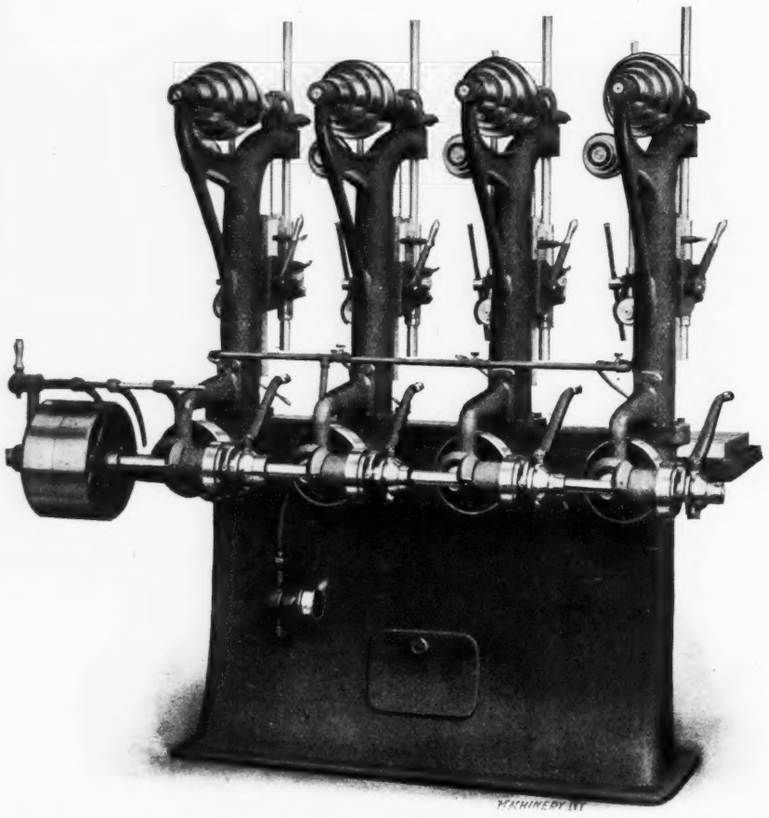


Fig. 2. Rear View of Gang Drill, showing Arrangement for Driving with one Continuous Shaft

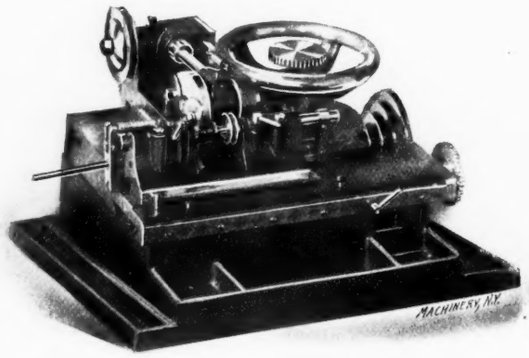
These machines are also furnished without power feed and can be arranged in gangs with any number of spindles from two up. They are also furnished on individual base columns, both with and without power feed construction, and with a variety of tables furnished according to the needs and requirements of the customer. An oil pump and the necessary piping is provided as shown, and a tank or reservoir for the oil is placed within the base.

WALTHAM AUTOMATIC STAFF TURNING MACHINE

The machine shown in the accompanying illustration has recently been brought out by the Waltham Machine Works, Waltham, Mass. It is built for automatically turning several shoulders on small work, such as the staffs of watches clocks, etc., at one setting. The general design of the machine is as follows: Two slides are provided, one of which carries the work supported on dead centers and driven by a dog from a belt-driven plate. The other slide has a motion at right angles to the first, and carries the tool or tools. A vertical shaft at the rear of the machine carries two cams, one for each slide, the cams actuating the slides by means of sliding wedges which are in contact with hardened rolls on the slides. These latter are kept up against the wedges by springs and the wedges are kept in contact with the cams by similar means. The angles of the wedges are such that the longitudinal movement of the wedge transmits a reduced movement of the slides. For watch work the movement of the work slide is made one-quarter, and of the tool slide one-eighth, of the longitudinal travel of the wedge, but for larger work a different reduction may be made. This arrangement is advantageous, inasmuch as it makes it possible to greatly reduce any small inaccuracies in the cams, the rises of which are several times the required travel of the slides.

The head- and tail-stock spindles which carry the dead centers have longitudinal adjustment in their bearings, and are so designed that when the head-stock center is in its proper position, the other can be withdrawn for changing the work, by means of the lever at the left of the tail-stock. In this way staffs can be turned with all the lengths gaged from the same end, thus throwing all of the errors of the blank to the extreme of the other end where they can be easily rectified. The centers are kept in contact with the work by light springs. For watch work and other work where the total length of the blanks is less than three-quarters inch, the head- and tail-stock are made in a single casting so that correct alignment is more easily maintained. For larger work, however, they are made separately adjustable on a bed plate. In both cases a screw adjustment is provided so that a slight swivel motion is possible for bringing the axis of the centers parallel with the work slide.

A worm and worm-gear drives the cam shaft, and a friction clutch connects the gear with the shaft. This clutch, when released, permits the shaft to be turned by the hand-wheel at the top, so as to make it easier to set the tools. The cams can be cut so that the tools will turn either straight or tapered work, or partly straight and partly tapered. A screw adjustment on each side permits the diameter of the most particular part and the distance of the most important shoulder from one of the ends to be obtained very accurately. The other diameters and lengths will be in correct relation, and duplicate parts can be turned as long as the tool retains its cutting edge. For very delicate watch work and also for work where a considerable amount of stock is to be removed, two cuts should be taken over the work. In order to facilitate this operation a two-tool turret has been provided. This turret is automatically indexed on the completion of each cut. The position of one of the tools in the turret is determined by the screw on the slide, but a separate screw adjustment is provided for the other, so as to make it possible to take the finishing cut with independent adjustment. With this arrangement only the finishing tool is required to have the keen point necessary for delicate work, and as but a small amount of stock is removed in the finishing cut, the tool will hold its edge for a long time.



Automatic Staff Turning Machine, built by the Waltham Machine Works, Waltham, Mass.

The operation of the machine is briefly as follows: The blank is dogged by the operator, who places it between the centers and starts the machine by a foot treadle. The tool follows the course determined by the cams, turning and squaring all the shoulders on one end of the staff. In a sin-

gle-tool machine the tool then returns to its original position, and the machine stops for the insertion of a fresh blank, which has been dogged by the operator while the machine was running. In a two-cut machine the turret is automatically indexed on the return, bringing the finishing tool in position, and the movements are repeated, the machine stopping first after the completion of the finishing cut, but with the turret indexed again and the roughing tool in position for the next blank. With the two-cut, or with the one-cut machine on long work, the operator can take care of two machines. The capacity of the machines when arranged for larger work is up to 2½ inches long between the centers, and up to ½ inch diameter, but the longest total turning is 1½ inch. The base of the machine is 15 inches square, and the weight about 140 pounds. The machine can be made to take either rectangular or circular tools, as required by the user.

KEARNEY & TRECKER UNIVERSAL MILLING ATTACHMENT

The accompanying line engraving Fig. 1 and the half-tones Figs. 2 to 5 show the construction and application of a universal milling attachment which has recently been brought out by the Kearney & Trecker Co., Milwaukee, Wis. Referring first to the line engraving, Fig. 1, showing a section of the device, it will be seen that the gear *A* is attached to the regular horizontal spindle of the milling machine, and drives

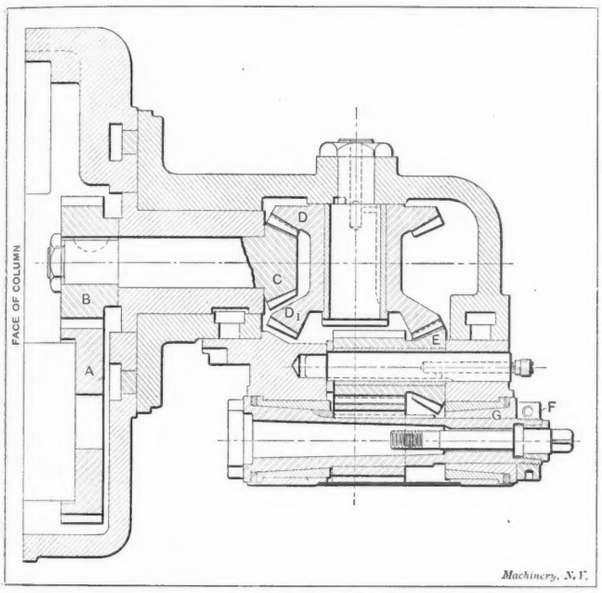


Fig. 1. Section through Universal Milling Attachment made by the Kearney & Trecker Co., Milwaukee, Wis.

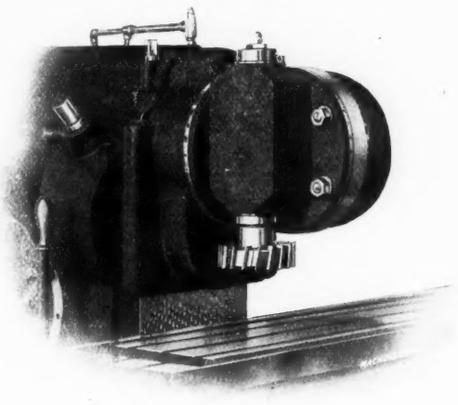


Fig. 2. The Attachment in Position for Vertical Milling

gear *B* keyed to a horizontal driving shaft on the end of which is cut a bevel pinion *C*; this pinion drives the bevel gear *D*, which latter is made in one piece with the bevel gear D_1. This arrangement permits the pinion *E* to revolve to any position without interfering with the driving pinion *C*. The bevel pinion *E* is cut on a steel sleeve on which also are cut spur gear teeth of wide face meshing with a similar gear provided on the cutter spindle of the attachment. All of the gears as well as the cutter spindle are made from hardened steel, the spindle being ground on the outside as well as in the tapered hole.

The wear on the bronze boxes is taken up by an adjustment nut or collar shown at *F*. The bushing *G* rotates with

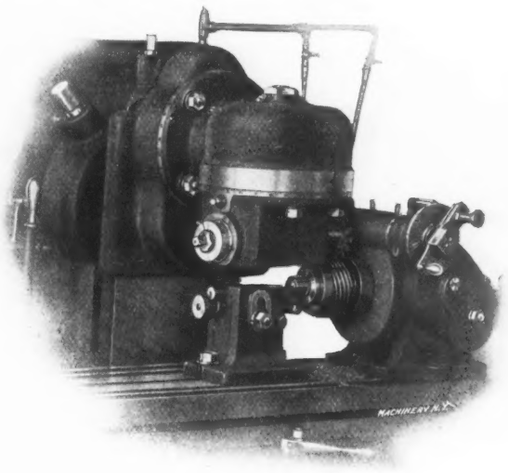


Fig. 3. The Attachment used in Connection with the Spiral Head

the spindle, it being keyed to the latter, although this is not shown in Fig. 1. Thus when the nut *F* is tightened, this bushing slides forward, and the spindle is at the same time drawn back into the taper box of the front bearing. The end of the spindle is provided with a slot or keyway for driving arbors carrying face mills and large milling cutters in general. The attachment has been made unusually heavy and rigid, and the object in bringing it out has been to provide means for using the milling machine on all kinds of unusual

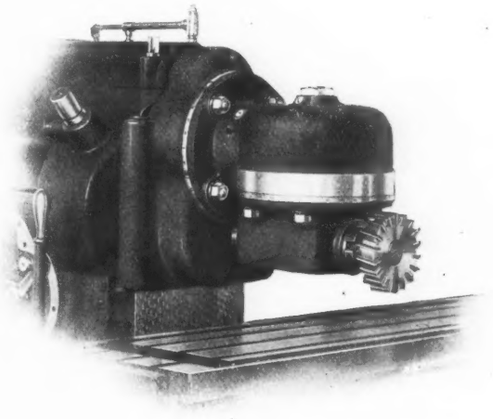


Fig. 4. Using the Attachment for Horizontal Milling at a Slight Angle with the Axis of the Main Spindle

jobs that from time to time arise in every shop, and which the ordinary machines with regular equipment are not sufficient to handle. The attachment will fit all sizes of milling machines built by the makers. It is held in place by being clamped to the knee slide on the column of the machine, the same as the vertical spindle and other attachments of this type, and it can be attached or removed very quickly and without difficulty.

In Fig. 3 the attachment is shown applied to the machine, with its spindle at right angles to the axis of the regular milling machine spindle but parallel with the table. It is here shown operating in connection with the spiral head. In Fig. 2, the attachment is shown in position for vertical milling, and in Fig. 4, for horizontal milling but in a position at a slight angle with the axis of the main spindle. Finally in Fig. 5 it is shown set for angular milling.

This device in connection with the regular horizontal milling machine makes it possible to do all classes of milling on this type of machine, and due to the fact that the attachment has been built along heavy lines, it is possible to perform vertical and angular milling practically to the full capacity of the main spindle of the machine. It has a capacity for face milling with cutters up to 6 inches in diameter. The attachment is made in three different sizes, all being

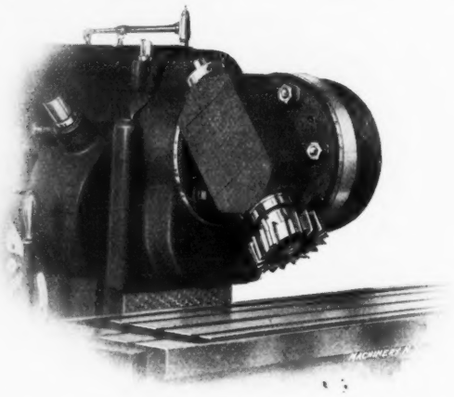
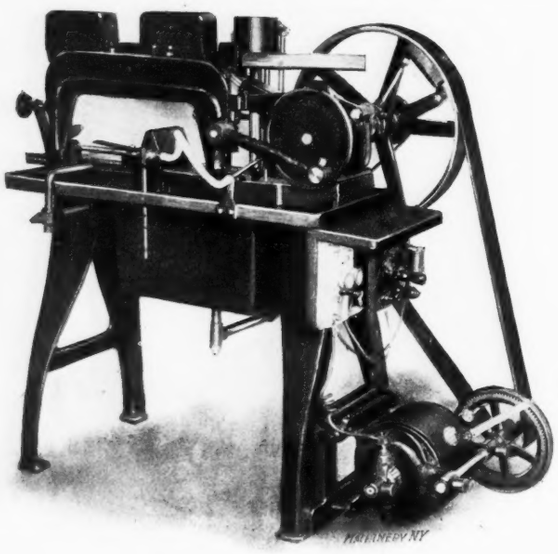


Fig. 5. The Attachment in Position for Angular Milling

provided with No. 10 Brown & Sharpe taper hole in the spindle. The distance from the center of the spindle to the bottom of the attachment does not exceed 1 9/16 inch, and the distances from the center of the spindle to the face of the column when used for vertical milling is 10⅞, 11¼ and 11½ inches, respectively, for the three different sizes. The net weights of the attachments are 265, 290 and 325 pounds, respectively.

RACINE MOTOR-DRIVEN HACK-SAW MACHINE

A hack-saw manufactured by the Racine Gas Engine Co., Racine Junction, Wis., was illustrated and described in the New Machinery and Tools department in the July, 1908, issue of MACHINERY. This machine has now been equipped with direct motor-drive, as shown in the accompanying illustration.



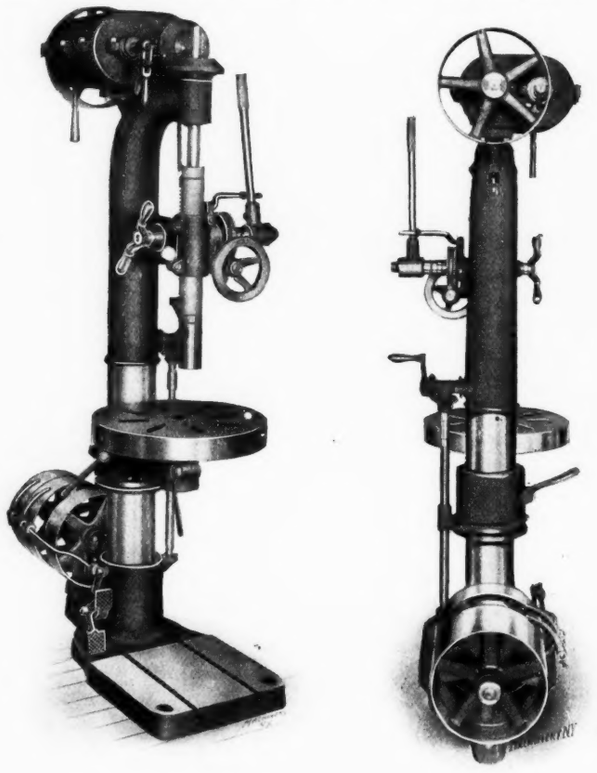
Motor-driven Hack-saw Machine, manufactured by the Racine Gas Engine Co , Racine Junction, Wis.

An important feature in this machine is that means are provided for lifting the saw from contact with the work on the back stroke, thus lengthening the life of the saw and increasing the rapidity of the cutting as well as leaving a smooth surface on the ends of the cut-off work. As will be seen in the illustration the motor is mounted on the lower part of one of the legs of the machine, reduction gearing being provided, and a belt transmitting the motion from the small lower pulley to the large driving pulley. As examples of the capacity of the machine it may be mentioned that a 1½-inch round cold-rolled steel bar can be cut off in 1½ minute, using common hack saw blades, no special blade being required in the machine. Another example of the capacity is that a 70-pound steel rail can be cut off in six minutes.

A special arrangement has been introduced for lubricating the saw while cutting. As seen in the illustration, a rubber hose connects a pipe to the right, which is fed directly from the oil pump, with an adjustable spout over the saw. As will be seen, this spout is mounted on the top of a rod which passes through the side of the bed and is held in position by means of a thumb screw. At the top of the rod a bracket is provided so that the spout can be swiveled about it. This combination makes it possible to raise or lower the spout as well as turn it to any position required.

SIBLEY HIGH-SPEED DRILL PRESS

The accompanying illustrations show a front and rear view of a high-speed drill press recently brought out by the Sibley Machine Tool Co., South Bend, Ind. It has been designed es-



Figs. 1 and 2. Front and Rear Views of 24-inch Drill Press, built by the Sibley Machine Tool Co., South Bend, Ind.

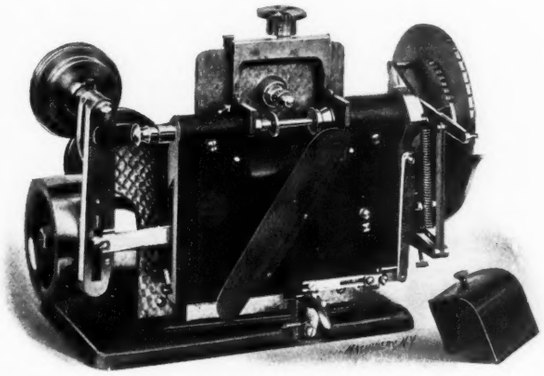
pecially with the view of meeting the demands of the automobile trade, and is provided with some features, new in upright drills, the most prominent of which is the location of the change gear box, which is placed on the top of the column, thus eliminating cone pulleys entirely, the drive being by means of a single constant-speed pulley. The gear box permits of eight changes of speed, and the construction is such that any speed can be thrown in instantly while the machine is running. The change speed gears in the gear box run in oil. The machine shown in the illustration is provided with combined hand-wheel and lever feed, but the machine is also made with geared power feed, if desired. The spindle is fitted with a hole for No. 4 Morse taper, and is provided with ball thrust end bearings. All running bearings are made of bronze. The machine has ample power to run high-speed steel drills of 1½ inch diameter up to the limit of their capacity.

WALTHAM AUTOMATIC GEAR-CUTTING MACHINE

In the June, 1908, issue of MACHINERY an automatic precision gear cutting machine built by the Waltham Machine Works, Waltham, Mass., was illustrated and described. The

accompanying engraving shows an improved design of this machine, differing from the one previously described in many important details. The machine is especially well adapted for cutting brass gears on account of the complete protection from chips provided for the indexing mechanism, the cams and the slides; but it is also suitable for other work and will cut steel gears and pinions of fine pitches satisfactorily. The protection for the working mechanism is obtained by means of a plate attached to the cutter slide and held in contact with the back side of the hood on the work slide. A removable cover also completely encloses the work and cutter, except for an opening below the work through which the chips fall.

During the return of the work slide, after the cut is taken, the cutter is lifted from the work so that the indexing can take place on the return stroke without loss of time. The location of the work slide in relation to the cutter can be adjusted laterally, and the depth of the cut is adjusted by a small handwheel, provided with graduations, at the top of the cutter slide. A large index plate is provided so as to insure accuracy of the divisions, and the different divisions are obtained by the adjustment of a single screw.



Automatic Gear-cutting Machine for Small Work, built by theWaltham Machine Works, Waltham, Mass.

With a "one-cut" machine, *i. e.*, a machine intended to cut to full depth at once, the feeding of the slides and the indexing of the work is continued automatically until all the teeth have been cut, and then the machine stops. With a "two-cut" machine, after the completion of one revolution of the work, the cutter is fed downwards a little deeper for a finishing cut, and the operations are continued another cycle, the machine stopping first after the completion of the second revolution of the work. This feature is of great value when cutting fine pitch teeth or very smooth work, as a finishing cut can, in this way, be made automatically without the attention of the operator.

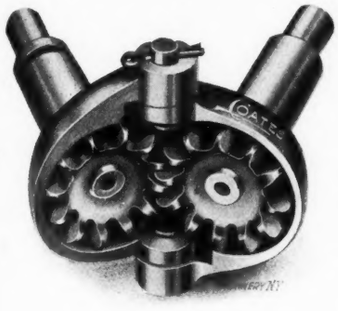


Fig. 1. Universal Coupling Drive operating at any Angle, made by the Coates Clipper Mfg. Co.' Worcester, Mass.

Two sizes of this machine are made; the smaller size is adapted for work up to 1¼-inch diameter, 32 diametral pitch in brass, and 48 diametral pitch in steel. The longest stroke of the work slide in this machine is 1⅜ inch. The base of the machine is 9½ x 12½ inches, and the weight is 115 pounds. The larger machine cuts up to 3 inches diameter, 24 diametral pitch in brass and 32 diametral pitch in steel, the longest stroke of this machine being 3 inches. The size of the base is 11½ x 19½ inches and the weight 285 pounds. If required, a pump and a pan base will be provided for steel work.

COATES MONGREL GEAR UNIVERSAL COUPLING DRIVE

The problem of a satisfactory universal joint, which will work well and transmit power without excessive losses, whether the two shafts to be connected are entirely in line or at a very acute angle with each other, has always been an interesting one to machine designers. A great many universal joints have been brought out which will work very satisfactorily as long as the angles between the two shafts connected do not become too great; but few universal drives will work well when the angle of deviation of the axis of one

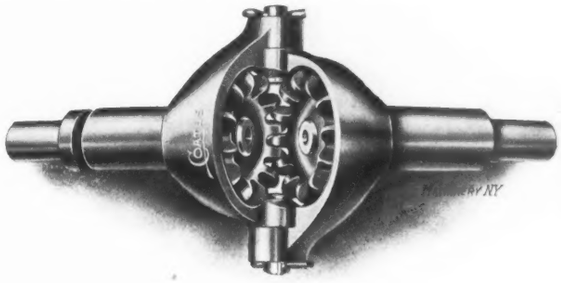


Fig. 2. The Universal Coupling in a position where the Two Shafts are more nearly in Line than in Fig. 1

shaft to the axis of the other becomes more than 45 degrees. The accompanying illustrations, therefore, of the Coates mongrel gear universal coupling drive, will be of particular interest.

This device is manufactured by the Coates Clipper Mfg. Co., Worcester, Mass., and its construction makes it possible to transmit power between two shafts either when they are practically parallel, or at a very acute angle as in Fig. 1, or when more nearly in line as in Fig. 2. When the two shafts are entirely in line, as in Fig. 3, the joint becomes practically a positive coupling, while in Figs. 1 and 2 the action is that of bevel gearing, the teeth cut on the parts keyed to the ends of each of the two shafts engaging with each other. The action and construction of the device is very plainly seen from the illustrations and there is little to be said in this respect. The cutting of the teeth in the gears is an interesting operation, and may deserve brief mention. The teeth are cut automatically on one of the Standard Mfg. Co.'s automatic gear cutting machines, shown in the May, 1906, issue

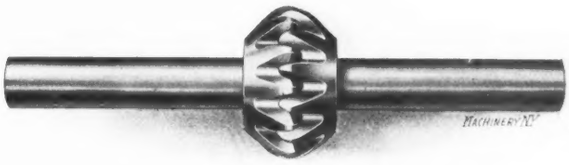


Fig. 3. The Mongrel Gear used as a Postive Coupling

of MACHINERY. This machine is provided with special cams so that the peculiar form in the bottom of the teeth which is not a straight line but a convex curve may be obtained while the cutter passes once across the work. By means of this machine it is possible to, automatically, first feed the cutter forward and then downward, thus obtaining the required shape of tooth.

Owing to its peculiar construction and the possibilities of drive which present themselves in this device, it will undoubtedly be of interest to mechanical men, as it is possible by means of this combination to use angular drives that would be difficult or impossible for regular universal joints or couplings.

DRAFTING TABLE

A new type of draftsman's table has recently been added to the line of drawing-room appliances manufactured by the Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass. The particular features of the table are the means for vertical adjustment, and the fact that the table or drawing board proper can be tilted to any angle desired. The top is made of well-seasoned white pine and is cleated to prevent warping, the cleats being so arranged that the shrinkage and expansion are taken care of. Universal drafting machines and parallel rules may be applied to the board if desired.

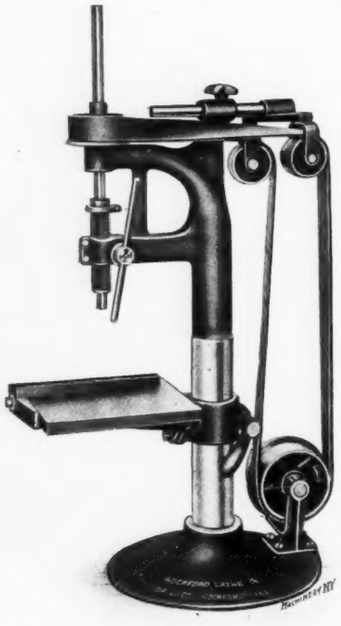
On the under side of the table two cast iron brackets are fastened, these brackets swiveling on the ends of the upright spindles. These swivels are clamped by two nuts operated by means of the small hand-wheel shown on the right-hand side directly below the board. The raising and lowering of the table top is accomplished by the hand-wheel shown near the right-hand upright. Two pinions meshing into racks set into

Draftsman's Table, built by the Washburn Shops of the Worcester Polytechnic Institute

the spindles are keyed to the hand-wheel rod. The raising and lowering feature is rather unique in that the spindles are always automatically locked in position and yet by simply turning the hand wheel in either direction the locking arrangement is released and the top is raised or lowered. The locking device is simple and requires no adjustment, and it has been shown by actual tests that it will stand 1,300 pounds pressure before slipping.

ROCKFORD TEN-INCH BENCH DRILL

The 10-inch sensitive bench drill illustrated in the accompanying half-tone engraving is manufactured by the Rockford Lathe & Drill Co., Rockford, Ill., formerly Rockford Machine & Shuttle Co. The countershaft for this drill can be placed either on the wall or on the ceiling, the driving cone being placed on the base of the machine to prevent vibrations. The driving belt from the pulley at the base to the pulley on the spindle passes over two idler pulleys. These are mounted in an adjustable bracket, so that by means of this adjustment the belt can be tightened as required. The table of the machine can be swung around the column, and can also be tilted to any position, making it very convenient in drilling angular and irregular work. A supporting bracket, as shown in the illustration, is provided, which can be placed on the table when drilling holes at an angle, for supporting the work and preventing it from slipping. The bracket can also be used for preventing work being drilled from revolving.

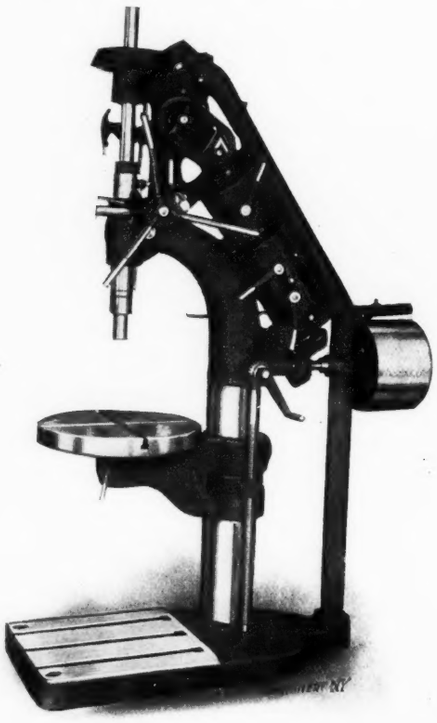


Ten-inch Bench Drill, made by the Rockford Lathe and Drill Co., Rockford, Ill.

The spindle is ¾ inch in diameter, its length being 17 inches. The lever feed of the spindle is 3 inches, and the vertical adjustment of the table 7¼ inches, the greatest distance from the spindle to the table being 10⅜ inches. The table is square, 8 × 8 inches. The driving pulley on the countershaft is 5 inches in diameter for a 1½-inch belt, and the speed of the countershaft is 550 revolutions per minute. The weight of the machine is 112 pounds.

BARNES 24-INCH UPRIGHT DRILL

The 24-inch upright drill illustrated herewith, has recently been brought out by the Barnes Drill Co., 602 S. Main St., Rockford, Ill. This machine is of the same general design as the 20-inch upright drill which was illustrated and described in the May, 1908, issue of MACHINERY, and which has now been on the market for more than one year, during which time it has proved exceptionally satisfactory. The 24-inch drill, while of the same general appearance is, of course, stronger and more powerful. It is of the all-geared type, and is capable of handling as heavy work as the ordinary belt-driven 28-inch drill. The machine has 20 changes of positive power feeds, ranging from 0.0015 to 0.031 inch. All the feed changes can be made instantly by the operator from his position in the front of the drill, without stopping the machine.



Twenty-four-inch Upright Drill, built by the Barnes Drill Co., Rockford, Ill.

The speed changes, including the throwing in and out of the back-gears, can also be made when the machine is running.

The capacity of the drill is up to 2-inch high-speed steel drills, drilling steel. As an example of the power of the machine it may be mentioned that a 2 9/32-inch hole has been drilled in one minute with ordinary carbon steel drills through 2 inches of cast iron at the highest back-geared speed (64 revolutions per minute), or at a feed of 0.031 inch per revolution. In another case a 1 29/32-inch carbon steel drill was pushed through steel 1 inch thick in 55 seconds at a speed of 100 revolutions per minute and a feed of 0.011 inch per revolution. This, in fact, was all that the carbon steel drill could stand. With a 1-inch high-speed steel drill, the machine will drill through 1½ inch in steel in 23 seconds without the back-gears, at a speed of 258 revolutions per minute.

The machine is regularly furnished with back-gears and positive power feed box, but if desired, it can be supplied without the back-gears and the power feed. The machine can also be supplied with back-gears, but without power feed. The table of the machine is provided with T-slots as shown in the engraving, or elongated holes or slots through it, as required. When an oil pump is provided with the machine, it is furnished with a square table, having an oil channel around the edges.

The total height of the drill is 78 inches. The distance from the column to the center of the table is 12¼ inches. The maximum distance from the spindle to the table is 30 inches, and the maximum distance from the spindle to the base is 44½ inches. The diameter of the table is 20 inches, and the diameter of the spindle is 1¾ inch. The spindle is provided with a No. 4 Morse taper hole. The vertical travel of the spindle is 14 inches and of the table 19¾ inches. The ratio of the back gears is 4 to 1. The driving pulley, which is 12 inches in diameter by 4 inches wide, should run at 325 revolutions per minute. The floor space, exclusive of the tight and loose pulleys, which overhang 10½ inches, is 44 by 20 inches. The net weight of the machine complete is 1080 pounds.

LANGELIER SIX-SPINDLE GANG DRILL

The accompanying half-tone illustrations, Figs. 1 and 2, show a front and rear view, respectively, of a sensitive six-spindle gang drill recently brought out by the Langelier Mfg. Co., Providence, R. I. This machine embodies some rather interesting features, the principal one of which is that any of the drill spindles may be brought down independently by operating the foot lever shown in Fig. 1. The machine is not intended for work requiring the drilling of six holes at once, but the object of the machine is to perform six drilling, tapping or reaming operations when they occur in the same piece of work; each spindle performs one operation and the jig or work is passed from one spindle to the other, successively. In a machine of this type it is evidently desirable that all the spindles be brought as close to each other as possible, so that the operator sitting in front of the machine can perform the work without moving from his seat. In order to make this possible, however, it is necessary for each of the spindles to be brought down independently of the others when it is performing its work, so that there is no interference between the other spindles and the jig or the work. This is accomplished by operating the foot lever which actuates the feed for each spindle separately in rotation.

Fig. 1. Six-spindle Sensitive Gang Drill, built by the Langelier Mfg. Co., Providence, R. I.

The connection between the foot lever and the spindles consists of a segment gear which meshes with a ratchet gear on the cam shaft, shown in the rear part of the machine. On this cam shaft is mounted a feed cam for each spindle, these cams being adjustable so that the feed of the spindle can be actuated in any desired manner. The ratchet arrangement prevents the cams from returning to their original position when the pressure on the lever is released so that in this manner one spindle after the other is successively brought into operation by the foot lever. Each spindle has also a hand feed acting independently of the foot feed and an adjustable stop is provided for regulating the depth of holes when drilling.

The spindles are fitted with No. 11 Skinner chucks and are capable of drilling 3/16-inch holes in steel. The vertical feed of the spindles is 2¼ inches. The distance from center to center of the spindles is 3¼ inches. The table of the machine has a working surface of 8 x 28 inches, and is adjustable vertically 4½ inches. The greatest distance from the end of the chucks to the lowest position of the table is 7 inches. The tight and loose pulleys on the countershaft are 5 inches in diameter for 2-inch belt, the countershaft running at 200

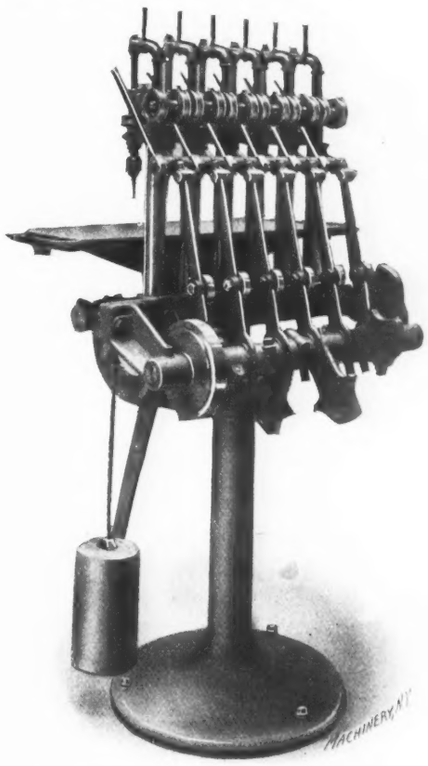
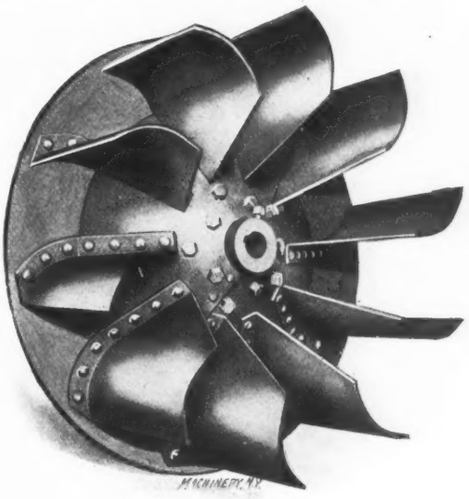


Fig. 2. Rear View of Gang Drill, showing Cam-shaft and Cams for actuating each Drill Spindle independently

revolutions per minute. These machines may be made in gangs with any number of spindles from two up to six, inclusive, and the distance between the centers of the spindles can be made to suit the requirements of the customer.

BUFFALO SLOW-SPEED EXHAUST FAN

A slow speed exhaust fan, designed particularly with a view of reducing the power consumed for driving, has recently been brought out by the Buffalo Forge Co., Buffalo, N. Y. The



Slow-speed, Low-power Exhaust Fan, made by the Buffalo Forge Co., Buffalo, N. Y.

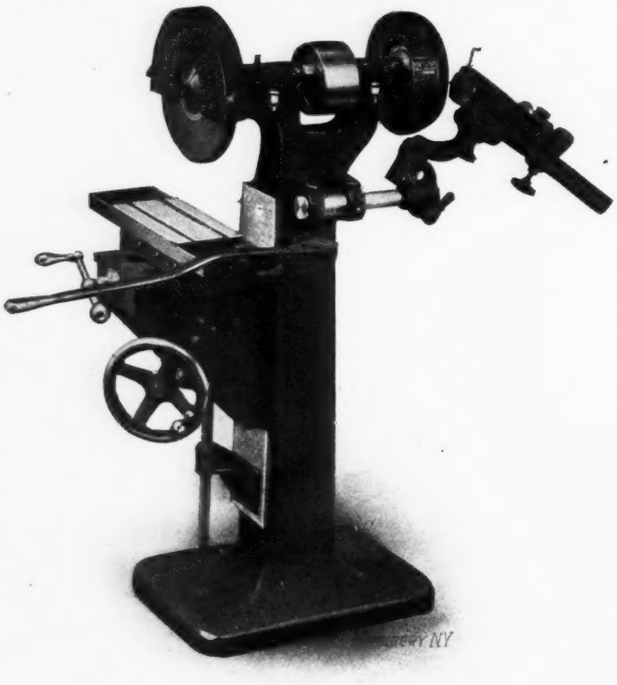
fan is known as the Buffalo slow speed low power exhaust fan, and runs at a 20 per cent lower speed than standard exhausters of the same size. It will, however, perform the same work as the standard fans with a 10 per cent reduc-

tion in power consumption. The blast wheel is built of heavy steel plate and instead of the spider usually employed for supporting the vanes, a steel plate cone is used. The apex of this cone is at the inlet of the fan so that the material to be exhausted, when entering the fan, strikes the cone, the direction of the material being gradually changed in this way without the loss of momentum due to sudden changes in direction. The cone offers no obstruction to the free passage of the material. The vanes are securely riveted to the cone and also to a heavy steel plate flange at the side opposite the inlet. This flange is extended beyond the tip of the vanes, preventing any material, thrown from the vanes, from coming in contact with a dead surface and retarding the progress. The fan is overhung on a shaft running in long journal bearings of the double ring oiling type. These bearings are supported on heavy cast iron pedestals in such a manner that the alignment of the fan is constantly maintained. The housing is built of heavy steel plate, securely bolted to a steel frame. It is adjustable to any angle of discharge on either side. All the necessary adjustments are quickly made on the outside of the housing. To change the direction of the discharge the bolts in the ring of each pedestal are loosened, and then the housing is revolved to the desired position.

These exhausters are applicable to various purposes, such as the removal of shavings, sawdust, refuse from wood-working machines and from buff and emery wheels, and from other abrasive processes. They can, of course, also be used for the exhaust of gases, acid fumes, etc.

WILMARTH & MORMAN SURFACE GRINDER

In order to meet the demand for a small convenient surface grinding machine of moderate capacity at a reasonable price, the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has placed on the market the machine shown in the engraving, known as the company's No. 1 surface grinder. This



Small Size Surface Grinder, manufactured by the Wilmarth & Morman Co., Grand Rapids, Mich.

machine has been built with a view of producing a machine equal in accuracy to larger machines, but limited to smaller work. The working surface of the table is 6 inches wide by 12 inches long, and sufficient movement is provided so that the grinding wheel can clear the working surface perfectly at both sides and at both ends. The transverse and vertical feed screws are provided with graduated dials with graduations reading in thousandths of an inch. These graduations are sufficiently coarse, so that even smaller sub-divisions can be readily obtained when such a degree of accuracy is required. The table is supported by the well-known knee and saddle construction used in milling machines, ample bearings being provided so as obtain the required rigidity. The vertical adjustment is obtained by a screw, as shown.

The machine is regularly provided with a grinding wheel of 12 inches diameter by 1 inch face, this wheel being intended to run at a speed of 1,400 revolutions per minute. The spindle bearings are cast in one piece with the column of the machine, which provides for rigidity and strength impossible to obtain when the spindle is carried by removable bearings. There is practically no overhang of the spindle at the end where the wheel is carried, thus increasing the capacity of the grinder for heavy cuts. On the opposite end of the spindle an additional grinding wheel is provided and the machine can be furnished either with or without the drill grinding attachment shown. Regularly it is furnished with this attachment which is of the well-known "New Yankee" type, which does not require any preliminary adjustments for bringing the drill in the proper position for grinding. The capacity of the attachment can be varied to suit the requirements of any individual shop.

NEW MACHINERY AND TOOLS NOTES

FOUR-SPINDLE DRILL: American Watch Tool Co., Waltham, Mass. This machine consists of four independent sensitive bench drills mounted on a cast iron base-plate and adjustable to any position along the base. The spindles are operated by a foot treadle on the floor. The base-plates can be furnshed in lengths varying from 10 to 23 inches.

QUICK ADJUSTING MICROMETER: H. O. Costello, 87 Oakland Ave., Providence, R. I. This tool is an improvement on the quick adjustment micrometer mentioned in a brief note in the November, 1908, issue of MACHINERY. By means of a ratchet arrangement the barrel is adjusted rapidly for position without making use of the micrometer screw for the full length of the adjustment.

BOLT POINTING MACHINE: Webster & Perks Tool Co., Springfield, O. This machine is intended for pointing the ends of rods from ¼ to ½ inch in diameter. The operation is very simple: The operator places the piece to be pointed in a vise against a stop and presses a foot lever; this grips the work and brings the cutter head forward. In this way, bolts can be pointed as rapidly as the operator can handle them.

SIXTY-DEGREE DRAFTING BOARD: Emmert Mfg. Co., Waynesboro, Pa. This drawing board, known as the Noyes board, slides at a 60-degree angle, its weight being balanced so that it moves easily up or down. The frame is placed on any flat top table, and is usually provided with a board or leaf in addition to the inclined one, which is nearly horizontal and which can be used for calculations and reference drawings.

SAW SHARPENING MACHINE: Hunter Saw & Machine Co., 59th and Butler Sts., Pittsburg, Pa. This machine has been designed for sharpening circular milling saws, and sharpens not only the faces and the tops of the teeth, but also bevels the cutting points in such a way as to materially add to the life of the saw and at the same time make it consume less power when in operation. Saws from 6 to 54 inches can be sharpened on the machine.

BREAST DRILL: North Brothers Mfg. Co., Philadelphia, Pa. With this drill two speeds are available, either of which can be obtained instantly, even when the drill is in motion. The tool is also so designed that it can be used either as a regular breast drill or as a right- and left-hand ratchet brace. These and other special features introduced in this drill, which differs considerably from the ordinary type, make it a very convenient tool for a great many different purposes.

ELECTRIC HOIST: Gustav Rasmus, 514 West 57th St., New York City. This hoist, while having a capacity of 5 tons, requires only 35¾ inches head-room, and weighs only 500 pounds. This is due to the fact that the motor is placed inside of the hoist drum, which constitutes the motor frame. The drive from the armature shaft is through a worm and worm-wheel, so that load and speed brakes are not required, as the gears are locked in position by the worm when the motor is at rest.

LARGE DROP HAMMER: Erie Foundry Co., Erie, Pa. This machine is of very large dimensions, it being a 3,500-pound hammer, with an anvil block weighing 70,000 pounds. The entire weight of the hammer is 98,000 pounds. The hammer is provided with a piston stop placed at the top of the cylinder, which protects the cylinder head against damage due to carelessness or to the breaking of the rods or pulling loose of the cross-head. Adjusting screws are provided for cross movement of the anvil for lining up the dies quickly.

PRECISION BENCH LATHE: American Watch Tool Co., Waltham, Mass. This machine is of the usual bench lathe type but some improvements have been introduced, particularly as regards the bearings for the spindle in the head-stock. The front end of the head-cone is also provided with graduations corresponding to the index holes at the back of the cone, mak-

ing it unnecessary for the operator to move from his position in order to set the index. The machine has a bed 36 inches long with a swing of 8½ inches and a chuck capacity of ⅝ inch.

BENCH PROFILING MACHINE: American Watch Tool Co., Waltham, Mass. This miniature profiling machine is designed along the same lines as the ordinary profiling machine with a vertical spindle and a guide located beside it. The vertical movement of the spindle is 1 inch and the cross movement 1⅞ inch. The slide or table below the spindle is capable of a 4-inch movement. By a simple arrangement the same handle operates both the vertical movement of the spindle and the side movement along the cross-rail of the slide carrying the spindle bearings.

DISK GRINDER: Ransom Mfg. Co., Oshkosh, Wis. This grinder, designed especially to meet the requirements of the automobile trade, is furnished with disks either 23 or 27 inches in diameter; one grinding disk is provded at each end of the frame or column, the driving pulley being placed in the center between the spindle bearings. The work-tables at each end of the machine have independent lever feed, so that two operators can work simultaneously. Both tables can be tilted to an angle of 45 degrees with the face of the disk, and can be raised or lowered as desired.

ARMOR PLATE SLITTING SHEAR: Buffalo Forge Co., Buffalo, N. Y. This machine is not intended for cutting armor plate, as the name would imply, but the frame of the shear is made from armor plate which is a particularly touch and tenacious material and possesses a high elastic limit, especially suited for a machine of this character, subjected as it is to sudden and severe strains. The shear will cut metal of any width up to ¼ inch in thickness, and while possessing the requisite strength, it is, owing to the material from which it is constructed, lighter than any shear of similar capacity.

MILLING ATTACHMENT FOR THE DRILL PRESS: E. C. Bliss Mfg Co., 91 Sabin St., Providence, R. I. This attachment is intended to be placed on the regular drill press table and is provided with slides in two directions so that milling operations can be performed by an end milling cutter placed in the drill press spindle. The working surface of the table is 8¾ by 21¼ inches, having a longitudinal movement of 9 11/16 inches and a cross movement of 5¾ inches. No swivel is provided, as the drill press table can be swung around when required. The adjusting screws have graduated collars reading to 0.001 inch. The weight of the device is 110 pounds.

IMPROVED LIFTING MAGNET: Cutler-Hammer Clutch Co., Milwaukee, Wis. An improvement of this company's lifting magnet, shown in the September, 1907, issue of MACHINERY, has recently been made. The new magnet is of a smaller size and lighter than those previously described, but its lifting capacity is nearly as great. In the design, attention has been given to the conditions under which a device of this kind is operated, and the magnet can be used out-of-doors in any kind of weather without damage. Pig iron has been unloaded from gondola cars by means of it at the rate of 100 tons per hour and at a cost of ½ cent per ton, as against 5 or 8 cents per ton for manual labor.

UNIVERSAL MONITOR LATHE: Dreses Machine Tool Co., 227-239 West McMicken Ave., Cincinnati, O. This machine, as the name indicates, is provided with a turret and turret slide, the latter being provided with set-over and swivel. The top slide has combined lever and screw feed, and all slides have taper adjusting gibs. The turret is locked by a gibbed square key. The head and bed of the machine are cast in one piece, with entirely enclosed friction back-gearing. The entire operating mechanism of the friction in the head can be put in place and removed without taking out the spindle. A taper attachment is provided, placed separately on the bed below the V's, having knurled screws for fine adjustment.

NEW LINE OF UPRIGHT DRILLS: Cincinnati-Bickford Tool Co., Cincinnati, O. This company has redesigned its line of upright drills, including the 20-inch sensitive drill, the 21-inch drill with stationary head and the 21-inch drill with sliding head. Among the improvements included in the 20-inch drill are graduations on the spindle sleeve and an automatic stop for tripping when the required depth of hole has been drilled. In addition, ample guards have been provided for all gearing. The 21-inch machine has been provided with a new tapping attachment. This machine is back-geared, the back-gears being operated by a lever-controlled clutch. Power feed is provided by means of cone pulleys and worm and bevel gearing. In the sliding head machine, the head has a movement of 17½ inches, the table a movement of 16¾ inches and the spindle a traverse of 9 inches, giving the machine a large range. Improvements in the design of the full line of upright drills from 24 to 42 inches have been made, to make the machines capable of using high-speed drills to their full capacity.

* * *

"Most of the books on trigonometry are elaborate enough for a surveyor or an astronomer. A machinist doesn't want so much. For him to learn it all is too much like scraping something true to a surface-plate where it only fits against thin air."—*Extract from a letter.*

CHICAGO DUPLEX FEATHER KEYSEATING MACHINE

In the August, 1909, issue of MACHINERY a description of the Chicago duplex hand milling machine was published. The accompanying half-tone engravings, Figs. 1 and 2, show this machine in operation with both the vertical and horizontal spindles in use simultaneously. When thus arranged, the machine is intended in particular for the quick handling of feather keyseating work. The horizontal spindle is fitted with an arbor having a No. 9 Brown & Sharpe taper shank, the shank being held in place by a draw bar. On this arbor is mounted the required cutter for cutting the desired width of the feather keyseat. In the vertical spindle is placed an end mill of the required size, which is held in place by a draw-in collet.

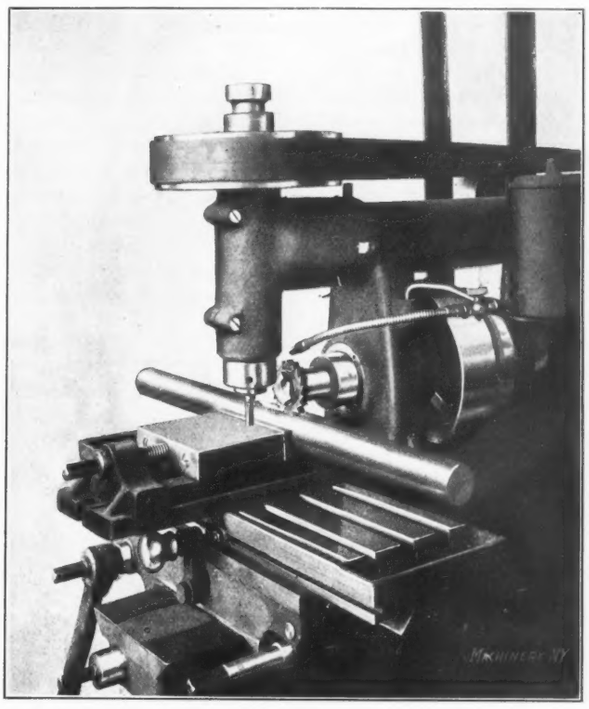


Fig. 1. First Operation in milling a Feather Keyseat on the Chicago Duplex Milling Machine

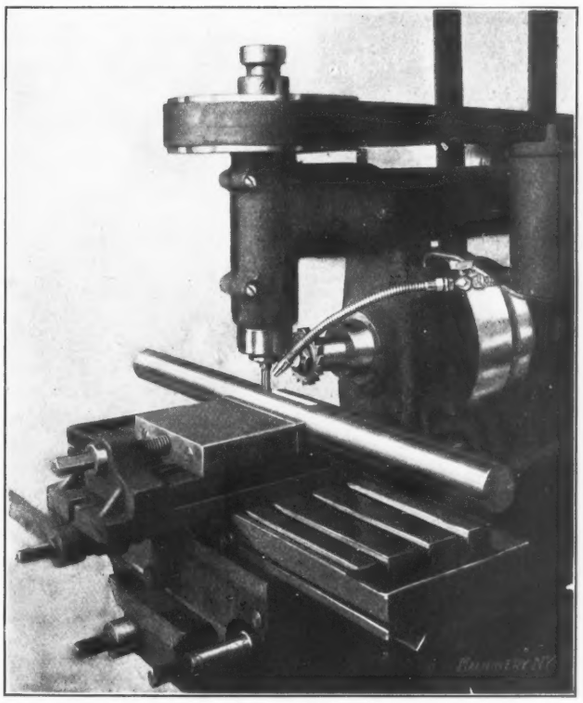


Fig. 2. Second Operation in milling the Feather Keyseat

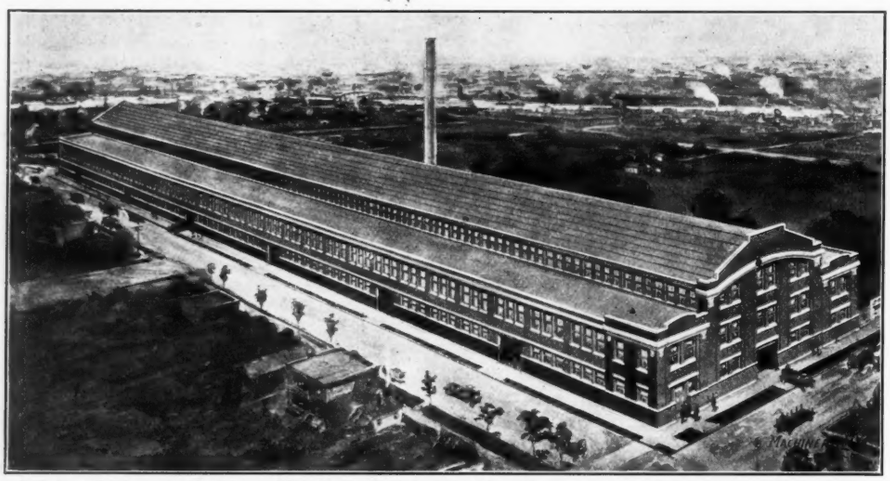
In Fig. 1, the machine is shown performing the first part of the operation of cutting a feather keyseat. The shaft in which

the keyseat is cut is held in a vise, and the side milling cutter shown mills out the keyseat excepting the finishing of the ends. This part of the operation is performed by the end mill in the vertical spindle, as shown in Fig. 2, where the table carrying the vise and shaft has been brought directly beneath the end mill. This makes a very handy arrangement for milling feather keyseats, as the two complete operations necessary for the milling can on this machine be made without resetting the work or even stopping the machine; thus, in reality, it may be considered as a continuous operation. The machine is equipped with six changes of power feed as well as crank and lever feeds, thus having a sufficient range to cover all ordinary work. The hand-lever feed is brought into service when the table is quickly returned after a cut has been taken. An adjustable automatic stop to the table feed is also provided which can be set for the length of keyseat desired. Hill, Clarke & Co., Inc., 125 North Canal St., Chicago, Ill., are the selling agents for this machine.

* * *

CHICAGO MACHINERY EXHIBITION WAREHOUSE

The illustration shows a new machinery exhibition warehouse just completed in Chicago that is 100 feet wide and 400 feet long and absolutely fireproof, being built of reinforced concrete throughout. It is located at 37th St. and Ashland Ave., on the Chicago Junction Railway, connecting with all railroads and boat landings. It was built by the Pfannmueller Engineering Co. to plans supplied by architect A. S. Alschuler, and was erected by general contractors J. P. & J. W. O'Connor.



Reinforced Concrete Machinery Warehouse just completed in Chicago at 37th Street and Ashland Avenue

The building is three stories high in front, two stories on the sides and one story in the center. The offices are on the three floors in the front of the building and run across the entire width of the building, giving office space on the second story 20 by 100 feet and on the third story 20 by 50 feet. The space in the center of the building, 50 feet wide by 40 feet high, runs the entire length of the building and is absolutely unobstructed. It is spanned by a 50-foot 25-ton Alliance traveling crane having a 6-ton auxiliary. The balconies on the sides are supported by massive concrete columns 20 feet apart, and these also support the crane runway. The spaces on the ground floor beneath the balconies are 20 x 25 feet, and may be partitioned off when so desired and thus make individual exhibition and storage rooms. In order that heavy machinery may be handled readily on the first floor, eye-bolts are set every ten feet in the brick wall to provide a means of attaching block and tackle to be used in connection with the crane for pulling heavy machinery into and out of these spaces. The balcony floors extend into the middle space 5 feet under the crane and are equipped with removable rails, thus providing a passageway and means by which the crane can serve the balcony. The building will be finished with all modern conveniences, including electricity, steam heat, ample toilet arrangements, shower baths, telephone switch-board with several trunk lines, etc.

Fig. 1. Ratchet Wrench for Tightening Tie-rod Nuts on Pipe laid in a Trench

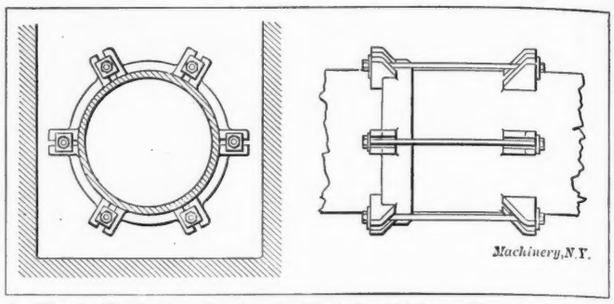


Fig. 2. Illustration showing the Work for which the Wrench shown in Fig. 1 was designed

In the rear of the structure there is a paved yard, fenced in, 100 feet wide and 160 feet long which will be used for rough machinery and metal products that do not necessarily have to be kept under cover. This space provides for the extension of the building. A private switch from the Chicago Junction Railway enters the building at the rear.

The building is located in the center of the manufacturing district and in the geographical center of Chicago. It is accessible by numerous car lines, and in view of the unsatisfactory conditions generally existing in Chicago affecting salesrooms and warehouses, it is believed that the new venture will fill a long-felt want. The fact that the equipment will handle heavy machinery at a minimum cost and that there will be no switching charges on carload shipments either incoming or outgoing, makes possible a big saving of charges now borne by the machinery warehouses not located so advantageously or provided with modern handling equipment.

* * *

RATCHET WRENCH FOR TRENCH WORK

The Philadelphia Gear Works was called upon recently to design some form of wrench for tightening 1¼-inch hexagon nuts at the bottom of a trench 3 feet wide and 10 feet deep. These nuts were on the tie-rods of a 20-inch cast-iron pipe line (see Fig. 2) where there was very little room in which to work, and some special arrangement was necessary for tightening them. To enlarge the trench was not advisable as excavating was done at so much per cubic yard, and as there were fifteen miles of pipe being laid, the idea of widening the trench at each joint to permit of the use of an ordinary wrench, was abandoned. The device shown in Fig. 1 was designed and does the work admirably. This wrench is simple in its construction as it consists of nothing more than a hexagon cup to fit the nut, a pair of miter gears mounted on a light frame, and a reversible ratchet and lever. As will be understood, the miter gears are to bring the ratchet shaft at an angle of 90 degrees with the axis of the wrench proper, so that the wrench lever is in line with the trench, thus giving plenty of room for its operation. With this device one man can tighten the two bottom nuts with less profanity and

time than is required to set up the four more accessible nuts with an ordinary ratchet wrench.

* * *

SPARKS AS INDICATIONS OF DIFFERENT KINDS OF STEEL*

The sparks given off when grinding iron and steel, by means of emery wheels, present a different appearance according to the kind of material ground. In the following, a review is made of the appearance of the sparks of different materials, and explanation is given of the causes of the differences, and the practical applications of this method of steel testing are pointed out.

The path of the spark from its origin to its extinction forms a line of light which may be called the spark-ray. This spark-ray consists of a line of light the end of which branches out in every direction, having an explosion-like appearance. It is this end of the rays that, in particular, varies for different classes of steel, and which in the following will be called the spark-picture. Some of these spark-pictures contain only a very few lines, while others contain a great many, some of them presenting secondary explosions and projections. The rays extending from the drop formation in the spark-picture have a strikingly higher speed than the particles in the spark-rays, and it appears as if they were suddenly thrown out in various directions by an internal force.

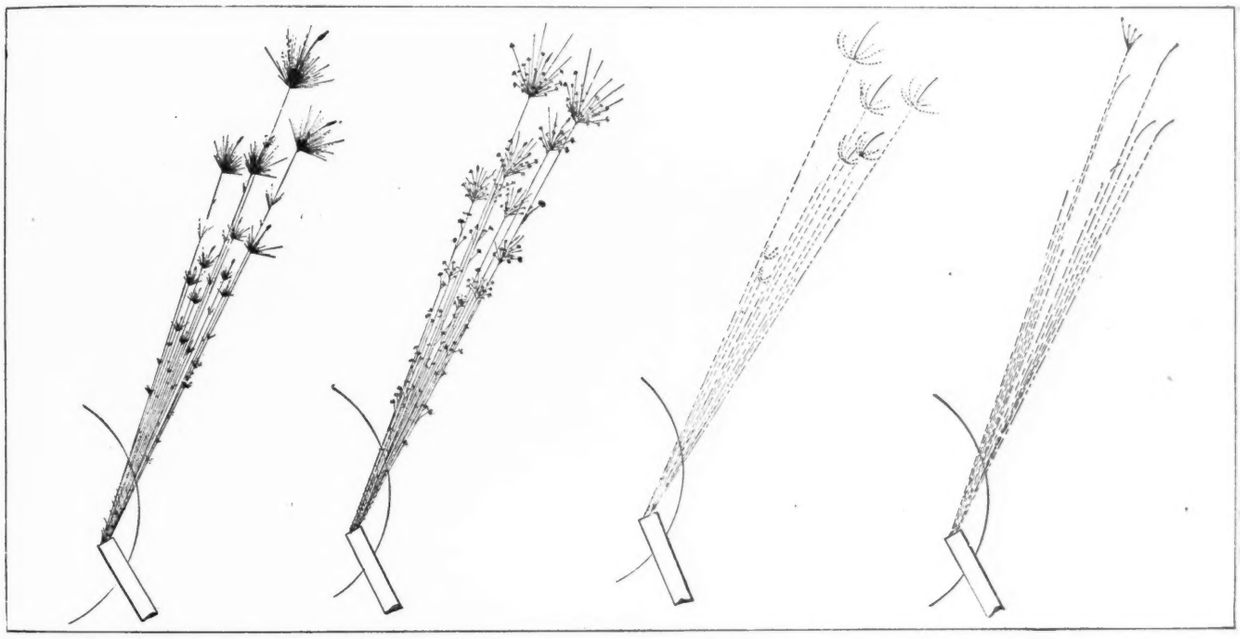


Fig. 1. Spark-picture indicating High-carbon Steel

Fig. 2. Spark-picture of a Tool-steel containing Considerable Manganese

Fig. 3. Spark-picture of Steel containing Wolfram

Fig. 4. Spark-picture of Molybdenum High-speed Steel

With a carbon content of from 0.07 to 0.08 per cent, the number of the lines in the spark-picture is from two to three. With an increase of the percentage of carbon the number of the branching lines also increases. At low carbon contents the lines appear to start from different points of the drop formation at the end of the ray, but when the carbon content is as much as 0.25 to 0.27 per cent the lines spring from a common point of the drop formation. The larger the carbon content the greater is the crowding of the lines projecting from the end of the ray. (See Fig. 1.)

The spark-picture of steel containing manganese (see Fig. 2) shows at the end of the individual branching lines a secondary explosion-like phenomenon, shorter lines collecting like leaves around a common central point. The number of the primary branching lines in this case also is in proportion to the carbon percentage in the steel; the extent and shape of the spreading ends of the primary branching lines appear to be in a certain relation to the percentage of manganese contained by the material.

In the case of tool steel, the spark-picture resembles the branch of a blossom, and the individual branching lines have a lilac-like form.

The spark-rays of steel containing wolfram are dark red lines, the ends of which show no spark-picture if the emery wheel is not sufficiently sharp and the pressure between the wheel and steel is small. Only the very end of the ray has a broader and more brightly glowing appearance, indicating the beginning of a spark picture. If the steel is pressed more firmly against the wheel, branching lines spring out in an explosion-like manner. These lines, however, take the form of small shining pin-head-like balls.

The spark-sheave (the combination of spark-rays and spark-pictures) of chrome-wolfram high-speed steel is distinct from that of the wolfram steel by the fact that two kinds of rays appear, some very thin dark red, and some thicker bright red ones, which are absent in the regular wolfram steel. The spark-pictures consist solely of short curved drop forms.

The spark-picture of nickel steel, containing less than three per cent nickel, is identical with that of carbon steel with a corresponding percentage of carbon. In case of larger percentages of nickel, however, the nickel steel can readily be recognized by the aid of the spark test, because the spark-pictures show themselves in a sporadic manner whereas in the case of carbon steel they occur in close proximity and in close succession to one another.

Dark gray cast iron is characterized by fine dark red spark-rays, spark-pictures here and there, and lines collecting around the drop formation like a net. The net-like lines disappear more and more with the increase of assimilated carbon, and with light gray cast iron they disappear altogether.

Theory of Spark Formations

The spark emitted when grinding is of course a particle of the metal being ground, heated to a high temperature by the friction between the emery wheel and the material. This particle of metal is thrown out in a tangential direction. At a certain point of its line of flight, the red hot spark assumes a red heat; it changes to white heat, and then transforms itself in an explosion-like manner into a spark-picture. At the moment of the explosion-like transformation the spark is in a fluid state. The latter statement can be proved by introducing a plate of glass at right angles to the line of flight and microscopically examining the glass. It is apparent that the sparks must be in a fluid condition, as they either splash asunder when striking the glass or form crystals of different shapes.

The increase of heat of the spark is caused by an internal source of heat represented, partly, by the combustion heat of the carbon, which suddenly burns. The heat of oxidation of

* Abstract from a paper by Mr. Max Bermann read before the Copenhagen Congress of the International Association for Testing Materials.

the exterior surface of the mass of sparks prevents too rapid cooling of the spark. The heat of cumbustion of the carbon provides the quantity of heat necessary for melting the metal. As a matter of fact, however, this heat is not sufficient to melt the whole mass, because the amount of carbon is too small, and only the mass of the unoxidized core within the oxidized iron crust is melted by the quantity of heat available. The combustion gases of the carbon burst the outer crust of the spark mass and throw out the fluid contents in the direction of the primary branching lines. The silicon and phosphorus contained also burn at the melting heat of the iron, and raise the temperature of the fluid mass. This theory explains why the size of the spark picture increases with the percentage of carbon.

Practical Applications of the Spark Test

The most important practical applications of the spark test may be stated as follows: Different kinds of iron may be classified according to their carbon percentage and the metals principally alloyed with them; ends of rods which may have been wrongly arranged on the storing racks may be placed against the revolving emery wheel and thus identified. It is stated that the spark test is so sensitive that differences of 0.01 per cent of carbon may be perceived. In the inspection of received material the method is valuable for making a rapid test to make sure that the material complies with the requirements. The spark test also supplies a sensitive means of ascertaining differences in chemical composition at different places of the same bar or piece of material, it being possible to apply this test to both steel and cast iron. In the hardening room the spark test may also be of value in order to make sure before hardening what grade and class of steel has been used for making the various tools, so that the proper hardening process may be applied. In the forge shop the method may be of value for determining with certainty good malleable wrought iron.

* * *

PERSONAL

G. W. Hoffman has been appointed sales engineer in charge of the Chicago office of the Hill Clutch Co., Cleveland, Ohio.

R. K. Loofbourrow is the newly appointed purchasing agent of the Electric Welding Products Co., Cleveland, Ohio.

H. O. Connelly, recently assumed the management of the New York office of the Cleveland Pneumatic Tool Co., Cleveland, Ohio.

B. L. Waters, of Aurora, Ill., is establishing an Eastern Branch of the Lyon Metallic Mfg. Co., in New York, with headquarters at 1365 Hudson Terminal Building.

Richard B. Sheridan has been promoted from chief sales engineer to assistant general manager of the Brown Hoisting Machinery Co., Cleveland, Ohio.

Charles F. Baehr, for twelve years with the Northern Electric Mfg. Co., has taken the position of superintendent of the Globe Machine & Stamping Co., Cleveland, Ohio.

Ernest L. Smith, lately eastern representative of the Standard Roller Bearing Co., Philadelphia, is now sales manager of the Grant-Lees Machine Co., Cleveland, Ohio.

Albert Bayton, formerly tool-room foreman for the Reed Mfg. Co., Erie, Pa., is now superintendent, succeeding F. Hubbard, deceased.

George W. Johnson, for the past four years superintendent of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned his position.

H. L. Hunter has been transferred from Edgemont, South Dakota, to Alliance, Neb., to take charge of the machine shops of the C. B. & Q. R. R.

W. M. Corse, secretary and treasurer of the American Brass Founders' Association, has been made works manager of the Lumen Bearing Co., Buffalo, N. Y.

William Perrine has been appointed master mechanic of the New Jersey Central and Lehigh and Susquehanna divisions of the Central Railroad of New Jersey.

George W. Fuller, for forty-seven years master mechanic of the Estey Organ Co., Brattleboro, Vt., has resigned his position and will spend the remainder of his life on "easy street."

Frank Davis, superintendent of the Haydenville Co.'s brass works, Haydenville, Mass., has resigned, and Fred Noble, assistant superintendent, has been made superintendent.

William Spire, formerly superintendent of the Marine Gas Engine Co. of New Jersey, has taken the position of mechanical engineer of the Electric Welding Products Co., Cleveland, Ohio.

A. N. Frecker, who has been for some years in the electric drill and grinder business at 95 Liberty St., New York, has been made general sales manager of the Van Dorn Electric & Mfg. Co., Cleveland, Ohio.

W. S. Howe, formerly advertising manager in charge of the small tools sales department of the Canadian-Fairbanks Co., Ltd., Montreal, has become associated with the S. A. Woods Machine Co., wood planer specialists, Boston, Mass.

Eugene Childs, formerly connected with the Trimont Mfg. Co., Roxbury, Mass., has been made president and general manager of the Springfield Drop Forge Co., Springfield, Mass, recently acquired by the Lakeside Forge & Wrench Co., Springfield, Mass.

W. S. Giel, lately superintendent of the Stoever Foundry & Mfg. Co., Myerstown, Pa., has severed his connection with that concern. Mr. Giel will devote his time to special work. His address is 3 Hamilton Park, New Brighton, Staten Island, New York.

Dr. W. H. Tolman, director of the Museum of Safety and Sanitation, 29 W. 39th St., New York, delivered an illustrated lecture before the National Machine Tool Builders' Association, Hotel Astor, October 13; also the same before the Liability Insurance Association at the Hotel Astor, October 20.

Howard Terhune, author of the article "Board Drop Hammer Design," published in this number, engineering edition, has resigned from the employment of Billings & Spencer Co., Hartford, Conn., and has taken a position with the E. W. Bliss Co., Brooklyn, N. Y.

Augustus M. Kelly, has resigned his position of foreman of the machine molding department of the Chapman Valve Mfg. Co.'s foundry, Springfield, Mass., to take the position of superintendent of the American Blower Co.'s foundry, Detroit, Mich., and has assumed his new duties.

H. A. Elliott, formerly with Alfred Schütte of Cologne, Paris and New York, has taken the position of American agent of Usines G. Derihon of Loucin, Belgium, specialist in the manufacture of automobile forgings. Mr. Elliott's headquarters are at 7502 Carnegie Ave., Cleveland, Ohio.

The personal note published in the April number stating that James W. Ogden, formerly superintendent of the Bridgeport Foundry & Machine Co., Bridgeport, Conn., had been made superintendent of the Wolverine Motors Works, Bridgeport, was erroneous. Mr. B. A. Yarrington is the superintendent.

H. J. Brandes, formerly connected with the Bullard Machine Tool Co., Bridgeport, Conn., in the capacity of superintendent, has severed his connection and has taken up the active management of the Springfield Mfg. Co., Bridgeport, Conn., maker of special grinders and emery wheels. Mr. Brandes purchased the business from Mr. George Jackman, who has retired.

Dr. William H. Tolman, director of the Museum of Safety and Sanitation, 29 West 39th St., New York, has completed arrangements for a lecture tour dating from October, 1909, to March, 1910, the itinerary of which includes the principal cities and towns in the New England, Middle and Middle Western States north of the Ohio and east of the Mississippi River, and a few cities west of the Mississippi, comprising St. Louis, Cedar Rapids, Davenport, Des Moines, and Burlington.

Aguste Isaac, president of the Chamber of Commerce, Lyons, France, visited America in October to study industrial conditions with special reference to the apprenticeship training of young men for the machinist's and other trades. He found a striking similarity between labor conditions in France and America as regards difficulty of holding boys to the terms of their indentures. They have the bad habit in France of working a year or two and then leaving and hiring out to other manufacturers as journeymen. The consequence, of course, is that there are many "half-baked" French machinists.

* * *

OBITUARIES

Edward T. Coe, treasurer of the Coe Brass Co., Torrington, Conn., died at his home in New Haven, Conn., October 5.

Carl Wilcox, of Wilcox & Gibbs, New York, a sewing machine inventor, died at his home in Westport, Conn., aged sixty-five years.

L. L. Heller, president of the Sterling Motor Car Co., Binghamton, N. Y., was killed October 6 by being struck by a Lehigh Valley R. R. train, near Waverly, N. Y.

Albert J. Perks, partner of the Webster & Perks Tool Co., Springfield, Ohio, died at his home in Springfield, October 4, aged fifty-eight. Mr. Perks was born in Birmingham, England, and came to America with his parents when a child. His parents located at Dayton, Ohio, where Mr. Perks spent his boyhood. He moved to Springfield when about eighteen, and since then has been actively engaged in manufacturing enterprises. For a number of years he was superintendent of the bar and knife department of the old Whiteley Machine Co., located where the Foos Gas Engine Co. now is. In October, 1891, he severed his connection with the Whiteley interests and entered into partnership with John F. Webster to manufacture machine tools under the firm name of Webster & Perks

Lewis C. Grover

Tool Co. Mr. Webster died in December, 1893, and Mr. Perks carried on the business alone until 1898, when Mr. Herman Voges, Jr., became associated as a partner in the business, which arrangement was carried on up to the time of Mr. Perks' death. Mr. Perks was an expert mechanic and machine designer, and an inventor of a number of valuable appliances. He is survived by his widow and two sons, George W. and Bert W.

LEWIS C. GROVER

Lewis C. Grover, chairman of the board of directors of Colts Patent Fire Arms Mfg. Co., Hartford, Conn., and for several years president of the company, died at his home in Hartford, September 30, following an illness of about three years. Mr. Grover was born, 1849, in Springfield, Mass., and was educated in the public schools. He served an apprenticeship to the machinists' trade in the Norwalk Iron Works, South Norwalk, Conn., and such was his aptitude for mechanical work that he was made foreman on the completion of his apprenticeship term. When only twenty-eight he accepted the position of general manager of the Whitney Arms Co., at New Haven, which position he held six years. In 1886 he was made assistant superintendent of the Colts Patent Fire Arms Mfg. Co., and soon became superintendent, and then general manager. In 1902 he was elected president and a director of the company to succeed John H. Hall. He was also elected president of the Colts Arms Co., of New York. He resigned the office of president of both companies last January because of poor health, but was elected chairman of the board of directors of each company. Mr. Grover was a man highly esteemed by his friends and employes. He was an indefatigable worker, and, although a broad-minded manager who understood how to delegate authority to subordinates and hold them responsible for results, no detail of the large manufacturing business which he managed was too trifling to receive his attention.

* * *

COMING EVENTS

November 9.—Monthly meeting of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York. Two papers will be presented; one by Prof. Gaetano Lanza and Lawrence S. Smith of the Massachusetts Institute of Technology on reinforced concrete beams, and the other by Prof. Walter Rautenstrauch of Columbia University on stresses in curved machine members. The paper on reinforced concrete beams compares the results of tests upon full size beams made at the Massachusetts Institute of Technology and the University of Illinois with three different theories of beams of this type. The paper on stresses of curved machine members outlines the method of procedure for the design of principal sections of hooks, punch and shear frames and other curved machine parts. Experimental results will be submitted in support of the theory presented. Calvin W. Rice, secretary, 29 West 39th St., New York.

November 18-19.—Annual meeting of the Society of Naval Architects and Engineers, Engineering Societies Building, 29 West 39th St., New York. W. H. Baxter, secretary, 29 West 39th St., New York.

November 19-20.—Annual meeting of the Ohio Society of Mechanical Electrical and Steam Engineers, Lima, Ohio. David Gaehr, secretary, Schofield Building, Cleveland, Ohio.

December 1-3.—Annual convention of the National Society for the Promotion of Industrial Education. An exhibition of school work from all over the United States will be one of the features. J. C. Monaghan, secretary, 20 West 44th St., New York.

December 7-10.—Annual meeting of the American Society of Mechanical Engineers in the Engineering Societies' Building, New York. Mr. Calvin W. Rice, secretary, 29 West 39th St., New York.

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Vieweger, American manager, 56 Church St., New York.

NEW BOOKS AND PAMPHLETS

ANNUAL REPORT OF STATE GEOLOGIST OF NEW JERSEY FOR 1908. 159 pages, 6 x 9 inches. Published for the State by Mr. Henry B. Kümmel, State geologist, Trenton, N. J.

TRANSACTIONS OF THE NATIONAL ASSOCIATION OF COTTON MANUFACTURERS: No. 86. 556 pages, 6½ x 9¾ inches. Secretary and Treasurer C. J. H. Woodbury. Room 501, 45 Milk St., Boston, Mass.

MANUAL OF STEAM ENGINEERING. By W. H. Wakeman. 411 pages, 3 x 5½ inches. Published by New York Belting & Packing Co., Ltd., for distribution.

This manual will be found valuable by those concerned with the common problems coming up in the power plant. It treats of boilers, boiler feeders and steam engines. Many tables and rules are given that should be appreciated by the stationary engineer and others. Description for setting the valves of duplex pumps and calculating the horsepower of engines are examples.

MANUAL FOR ENGINEERS. By Chas. E. Ferris. 165 pages, 3 x 5½ inches. Published by University of Tennessee, Knoxville, Tenn. Price, 50 cents.

This manual, which is a revised edition, contains in convenient form many valuable tables and other data for engineers and business men. Some of the most important tables in the book are as follows: Areas and circumferences of circles; square and cube roots; natural sines, tangents and secants; steam tables dealing with capacity of turbines; extensive tables for electric wiring; interest tables, etc.

MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1910. 391 pages (including advertising), 3¾ x 6 inches. Published by Emmott & Co., Ltd., Manchester, England. Price, 6 pence.

This publication has become quite well known in the United States, this being the twenty-third year of publication. It treats of steam and steam engines, including compound and triple expansion types, details of construction, condensers and condensing plants and condenser details; steam turbines, boilers and boiler construction, chimneys, super-heating, feed water, fuels, gas and oil engines, gas producers, centrifugal pumps, beams and girders, shafting, gearing, ball bearings, belting, rope drives, wire ropes, bolts and nuts, screw threads, screw cutting, miscellaneous mathematical tables, etc.

METAL SPINNING. By Fred D. Crawshaw. 74 pages, 4¾ x 6¾ inches. 33 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Bound in cloth. Price, 25 cents.

Metal spinning, while once of considerable importance, is an art that is going into decline and, strange to say, it is one on which it is claimed no book had been published until the appearance of this work. The present practice is to employ drawing and forming press tools to produce the work that was formerly made on the spinning lathe. The work recognizes this fact and was written largely for the instruction of amateurs, trade schools, and the crafts which produce art work in limited amount. The tools, chucks and samples of work produced are illustrated and described. The book will be found of considerable general interest because of the fact that no other work on the subject has been published and also because of the interesting character of the operations and tools employed.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES. By Harrington Emerson. 171 pages, 5 x 7 inches. Published by the *Engineering Magazine*, New York. Price, $2.

This work is based on the articles published under the same title in the *Engineering Magazine* from July, 1908, to March, 1909, revised, rearranged and expanded by the author. Mr. Emerson is a well-known works management engineer who has given years of scientific study to the problem of efficiently employing labor and securing the highest efficiency by intelligent direction of effort. The philosophy of works management is slowly taking shape, and Mr. Emerson's treatment will be found exceedingly interesting by those concerned with it either in theory or in stern practice of everyday life. The contents by chapters are: Typical Inefficiencies and their Significance; National Efficiencies—Their Tendencies and Influence; The Strength and Weakness of Existing Systems or Organization; Line and Staff Organization in Industrial Concerns; Standards—Their Relations to Organization and to Results; The Realization of Standards in Practice; The Modern Theory of Cost Accounting; The Location and Elimination of Wastes; The Efficiency System in Operation; Standard Times and Bonus; What the Efficiency System may Accomplish; The Gospel of Efficiency.

NOTES ON PRACTICAL MECHANICAL DRAWING. By Victor F. Wilson and Carlos L. McMaster. 186 pages, 6 x 9 inches. 86 illustrations. Published by Wilson & McMaster, East Lansing, Mich. Price, $1.50.

This book which treats of lettering, orthographic projection, isometric and oblique drawing, use of instruments, working drawings, geometrical drawing, machine sketching, etc., has been revised, rearranged and enlarged by 25 pages for the third edition. The chapter on lettering describes the various types of lettering commonly used on mechanical drawings, and illustrates a number of examples. Considerable attention has been given to orthographic projection, examples being given from which the student can get a clear idea of the relation of the three common views used in the ordinary mechanical drawing. The sketches in phantom perspective are well executed and give the work an attractive appearance. Practical instructions are given for making working drawings that agree very well with the common usage of draftsmen in manufacturing establishments. The book is one that can be recommended to industrial schools and all students who wish to study mechanical drawing at home or to others who wish to obtain a knowledge of the common relations of views and methods of making drawings without going to the trouble of learning to draw.

POWER, HEATING AND VENTILATION. By Charles L. Hubbard. 647 pages, 6 by 9 inches, 412 illustrations. Published by the Technical Press, Brattleboro, Vt. Price, $5.

This book is intended for designing and constructing engineers, architects, etc. The subject of power is treated especially from the steam side, but sufficient information bearing on electrical matters is given to enable the intelligent arrangement of the steam plant with reference to the requirements of electric lighting and the distribution of electrical power. The subject of boilers is quite fully treated, and much valuable information is given on the construction of various types, the design of tubular boilers, boiler accessories, care and management, etc. The theory of the steam engine is taken up and descriptions of different types given, including the steam turbine. The subject of condensers is also treated, and the use and construction of cooling towers explained. A chapter devoted to steam and feed piping contains many valuable tables and formulas and also considerable information of practical value to the engineer. The problem of heating and ventilation as applied to all classes of buildings, from a small furnace-heated dwelling to buildings with central plants of the largest size, is fully treated. The various chapters dealing with this subject are as follows: Systems of Warming; Ventilation; Heat Loss from Buildings; Furnace Heating; Direct Steam Heating; Indirect Steam Heat-

ing; Direct Hot Water Heating; Indirect Hot Water Heating; Forced Hot Water Circulation; Fans; Forced Blast Heating and Ventilation; Exhaust Steam Heating; Electric Heating; Special Devices; Heating and Ventilating Different Types of Buildings; Care and Management of Heating and Ventilating Plants.

ELEMENTS OF MACHINE DESIGN. By Dexter S. Kimball and John H. Barr. 446 pages, 6 x 9 inches, 196 illustrations. Published by John Wiley & Sons, New York. Price, $3.

We have often been impressed by the fact that there is no American book on machine design that gives all of the many common subjects of machine design on which the designer is likely to require specific information. Reference usually must be made to a number of the available works before a satisfactory treatment of a given subject is found. The authors of the present work evidently having noted the shortcomings of previous writers have presented, we believe, a book on machine design that is more complete than anything of a similar nature put on the market by American publishers. The work is the outgrowth of the experience of the authors in teaching machine design to engineering students in Sibley College, Cornell University. The treatment of friction, lubrication and efficiency are sufficiently comprehensive for a work of this kind, as is also the work on springs, riveted fastenings, screws and screw fastenings, keys and cotters. The theory of stresses produced by force fits and the calculation of allowances is satisfactory, but an improvement is suggested in the shape of a table giving the results of practice in making shrink and force fits. So many factors enter into the problem that the result of practice on various classes of work would be exceedingly helpful to the designer who has not had the benefit of much experience. The treatment of tubes, pipe, cylinders, flues and tin plates was written with the advantage of the knowledge gained from the experiments made by the University of Illinois Engineering Experiment Station and the paper by Prof. Reid T. Stewart presented before the American Society of Mechanical Engineers, and, of course, is much more satisfactory than previous treatments available in other works on machine design. Journal bearings, pivots and roller bearings, are not treated in as comprehensive a manner as one who is especially interested in these subjects could wish, but probably as much space is given to these important subjects as the general plan of the work and the course of instruction for which it was prepared would permit. A portion of the book is devoted to axles, shafts and shaft couplings, belt, rope and chain transmission, application of friction including friction reels, friction brakes, friction clutches and pulleys. The treatment of tooth gearing is fairly satisfactory, there being forty-two pages devoted to the theory and practice of spur, bevel and helical gearing. Of course, the treatment of helical and spur gearing is brief and leaves a great deal unsaid. Following this chapter are chapters on fly-wheels and pulleys and machine frames and attachments. The work is one that we can heartily recommend to machine designers and others concerned with the problem of machine design, but it is not quite the comprehensive treatment that should be presented by some author. Whether a comprehensive treatment is practical is a matter for the publishers to decide, but the need for a good all-around work is evident to those who frequently refer to the present available books on machine design.

CATALOGUES AND CIRCULARS

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4698 of luminous arc head-lights.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4691 illustrating and describing small polyphase motors.

VALLEY BOAT & ENGINE CO., Baldwinsville, N. Y. Catalogue of marine engine castings and finished machine parts.

GISHOLT MACHINE CO., Madison, Wis. Leaflet illustrating the Gisholt 30-inch motor-driven vertical boring mill.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4692 describing the General Electric No. 210 Railway Motor.

BICKFORD & WASHBURN, INC., Greenfield, Mass. Blotter illustrating the Bickford & Washburn pipe tap thread milling machine.

PRENTISS TOOL & SUPPLY CO., 115 Liberty St., New York. Circular of the 20-inch universal drilling lathe built by Fay & Scott, Dexter, Me.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4099 superseding Bulletin No. 4444 on motor-driven air compressors, geared type.

SPICER UNIVERSAL JOINT MFG. CO., Plainfield, N. J. Catalogue of Spicer dust-proof and oil-tight universal joints for motor cars, motor boats and other machinery.

ARGUTO OILLESS BEARING CO., Wayne Junction, Philadelphia, Pa. Folder advertising the Arguto oilless bearings which save oil and prevent ruined journals.

W. S. CALDWELL CO., Louisville, Ky. Catalogue of Caldwell wooden tanks for manufacturing plants and other users requiring large and small tanks for the storing of water, etc.

CLEVELAND TWIST DRILL CO., Cleveland, Ohio. Folder entitled "The Paragon Way" illustrating the new "Paragon" flat taper shank high-speed twist drill lately brought out by the company.

W. S. ROCKWELL CO., 50 Church St., New York. Circular illustrating the Rockwell furnaces, and fuel oil or gas-burning appliances. A new catalogue is in preparation and will be issued shortly.

GEORGE W. SOUTHWICK CO., 35 Warren St., New York. Circular illustrating the Hammond wire belt lacing tool for making a wire hinged joint for machine belting. The cost of the outfit is $7.50.

HARBISON-WALKER REFRACTORIES CO., Pittsburg, Pa. Catalogue of silica, nickel, chrome, and fire-clay brick used by steel mills, brass foundries, and other concerns employing furnaces for melting metals.

J. S. OSGOOD, 131-138 Erie County Bank Building, Buffalo, N. Y. Blotter illustrating the Osgood indestructible file and tool handle which was recently specified by the United States Government for the Rock Island Arsenal.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Circular of the Cutler-Hammer pressure controlled speed regulator for use with motor-driven boiler draft fans, boiler feed pumps, gas pressure exhaust, etc. For description see MACHINERY, September, 1909.

ARTHUR D. LITTLE LABORATORY, Boston, Mass. Pamphlet by Harry S. Mork, engineering chemist, entitled "Selective Economy in Raw Materials," being a paper presented at the annual meeting of the American Chemical Society at the New Haven meeting, July 3, 1908.

MANVILLE BROS. CO., Waterbury, Conn. Circular of the "Yankee" power bench press, designed to take the place of the ordinary foot and screw press. It is made in three sizes with or without table. The stroke is 1, 1½ and 2 inches respectively.

PLANET ENGINEERING CO., 5 Beekman St., New York. Circular illustrating the constructive features of the Planet roller bearings for motor boats, thrust bearings, electric motors, centrifugal pumps, etc. This bearing is composed of rollers with the periphery a section of a spherical surface.

GEM MFG. CO., 3253 Spruce St., Pittsburg, Pa. Catalogue of "Gem" specialties, comprising steel and brass oilers, torches, oil carriers, tallow pots, flue scrapers, foundry chaplets, flexible shafts, rope-driven or motor-driven portable grinders and drills, electric polishing machines, universal joints, etc.

H. BRACHARACH, 720 Lewis Block, Pittsburg, Pa. Advance sheets of 1910 catalogue illustrating a German recording gage which measures and records pressure, draft, and velocity of gases. These gages are used in boiler plants, mine ventilating systems, gas producer plants, regenerative furnaces, etc.

THE GRAHAM MFG. CO., Providence, R. I. Blotter illustrating a Universal jig vise, which is made in three sizes with jaws 6, 9 and 12 inches long. This jig vise can be used as a plain drilling vise or for the drilling of interchangeable parts. It is a cheap substitute for expensive jigs on a large class of work.

GARDNER MACHINE CO., Beloit, Wis. Circular illustrating the Gardner grinder in use on intake manifolds, universal joints, pump cases, exhaust connections, jacket plates, and cylinder covers, all being examples of automobile work for machining which the disk grinder has been found to be a valuable tool.

BOGERT GAS POWER ENGINE CO., 1116 Chamber of Commerce, Buffalo, N. Y. Folder illustrating the Bogert tandem gas engine built in sizes from 50 to 500 horse-power; also Bogert tandem gas engines with no cross-head built in sizes from 50 to 150 horse-power and single cylinder gas or gasoline engines in sizes from 20 to 100 horse-power.

B. F. STURTEVANT CO., Hyde Park, Mass. General catalogue No. 165 illustrating the company's complete line of fans, blowers, dust collectors and conveyors, fuel economizers, motors, engines, turbines, generating sets, forges, hot blast apparatus, etc. Principal dimensions and other information regarding the apparatus illustrated is given briefly.

FRANK MCHALE, 302 Havemeyer Building, New York City. Catalogue of books relating to engineering subjects, including chemistry, mining, mechanical, electrical and steam engineering, construction, hydraulics, etc. Books will be furnished at the lowest market prices and forwarded prepaid to any part of the world on receipt of advertised price.

BRUCE-MACBETH ENGINE CO., Cleveland, Ohio. Catalogue of Meriam vertical gas engines for electric lighting, pumping, and general power purposes. The catalogue illustrates the four-cylinder engine built in sizes from 75 to 300 horse-power, and shows the details of construction. The two-cylinder type is also illustrated, and the four-cylinder engine with a gas producer plant.

NORTHERN MACHINE & REPAIR WORKS, Wausau, Wis. Circular of the "Little Giant" cutting-off machine for cutting tool steel, mild steel, cast iron, brass and other metals. The machine is of simple construction, being designed for use in shops that do not require an elaborate equipment and where a cutting-off machine with hand feeds answers all practical requirements

H. W. CALDWELL & SON CO., Western Ave., 17th-18th St., Chicago, Ill. General catalogue No. 34, of hoisting, elevating, conveying and power transmitting machinery for flour mills, grain elevators, cotton-seed oil mills, starch works, breweries, distilleries, malt houses, sugar refineries, cement works, phosphate works, tanneries, etc. The catalogue contains 847 pages, 6 x 9 inches.

OSCAR E. PERRIGO, 6 Beacon St., Boston, Mass. Circular outlining systematic methods in shop management and cost accounting, which Mr. Perrigo is prepared to install. He is a consulting and systematizing engineer who has given a great deal of attention to manufacturing methods and systems, and invites correspondence from officials having troubles with shop or office management.

DIAMOND MACHINE CO., Providence, R. I. Catalogue of grinding and polishing machinery, comprising floor grinding machines, motor-driven grinders, wet tool grinders, automatic face grinders, locomotive guide bar grinders, roll grinders, surface grinders, gun barrel machinery, internal grinders, lathe grinder attachments, drill grinders, polishing and buffing machines, polishing wheels, emery wheels, strapping machines, etc.

ROCKWELL FURNACE CO., 26 Cortlandt St., New York. Catalogue of forging, heating and welding furnaces. The catalogue has a novel trade-mark on the cover showing an animal known as "Go-Sum" which is said to be a cross between a hippopotamus and a grasshopper. The catalogue illustrates a large number of furnaces adapted for practically all classes of work in which portable or stationary furnaces are employed.

WELLS BROS. CO., Greenfield, Mass. Catalogue and price list of die holders principally designed for use on screw machines. The holder is firmly clutched in its forward movement and when not cutting the die is held by friction, thus doing away with the noise ordinarily noticeable on screw machines. The holders are adapted for the "Little Giant" adjustable dies which are of the same quality as the regular dies supplied by the company.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Catalogue of lifting magnets, giving a list of users and illustrating the uses to which lifting magnets are put in steel mills and other plants where sheet metal, steel rails, scrap and other metals are handled in large quantities. The possibilities of the lifting magnet are startling. One illustration, for example, shows a magnet lifting a locomotive cylinder, the magnet being applied to the planed surface at the juncture between the two cylinders.

D. O. JAMES MFG. CO., Chicago, Ill. Catalogue D of speed-reducing transmission gears (see MACHINERY, August, 1908, for description), for spur, bevel, miter, internal, spiral and worm gearing. The speed-reducing gears are designed to transmit the power of electric motors and other high-speed apparatus, reducing the speed to that required for machine tools, centrifugal pumps, elevators, etc. The catalogue contains valuable data on gearing, tables of natural trigonometrical functions, diagrams of circular pitch gears, etc.

SKINNER CHUCK CO., New Britain, Conn. Catalogue of independent universal and combination lathe chucks, drill chucks, planer chucks, face-plate jaws, drill press vises and reamer stands. The catalogue contains 48 pages, is made up with rounded corners, and is perforated for a loose leaf binder. The construction of the new Skinner gear pattern drill chuck is illustrated in sectional views, and a phantom view is shown of the Skinner positive drive drill chuck. The catalogue is one that will be found of general interest by users of machine tools and accessories.

NEW JERSEY FOUNDRY & MACHINE CO., 90 West St., New York. Catalogue of overhead carrying devices comprising trolleys, hoists, cranes, buckets, cars and tracking, etc. The Newhall patent steel frame I-beam trolley is illustrated in combination with a differential hoist. Various other combinations are shown and examples of installations. The company builds jib cranes suitable for foundry shops and other places where a jib crane is profitably used. The catalogue will be found of general interest by those concerned with the problem of hoisting and conveying materials either in the shop or in the field.

KEARNEY & TRECKER CO., Milwaukee, Wis. Catalogue No. 17 of Milwaukee milling machines. The catalogue illustrates the construction of the Milwaukee miller and two views are reproduced with reference numbers in red, each part being named below. Details of con-

struction are illustrated, including a vertical section showing the flooded lubrication system which has made Milwaukee millers famous. The company manufactures universal milling machines in three sizes, plain milling machines in three sizes, and manufacturing milling machines in two sizes. All styles have single pulley drive, all-geared feeds, and flooded lubrication.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio. Treatise on the crank shaper, describing the characteristics of the cone pulley drive, speed-box drive, and variable speed motor drive with particular reference to the Lincoln variable speed motor which gives an infinite number of running speeds throughout its range. The treatise which is sent free on request will be found of much general interest to designers and users of shapers. It gives valuable information not only regarding the power required to drive crank shapers under definite conditions of work, but also compares the productive efficiency of the belt-driven and motor-driven shaper.

DAVIS-BOURNONVILLE CO., 97 West St., New York. Pamphlet illustrating and describing the Davis-Bournonville oxy-acetylene apparatus which produces a flame having a temperature of about 6,300 degrees F. that can be used either for welding or for cutting metals. The oxy-acetylene torch is described as a "putting-on tool," which it is in fact, it being not only possible to weld together iron, steel, cast iron, brass, copper, platinum and other metals and to unite dissimilar metals but also to build up defective castings and other pieces wherein metal is required. As a cutting-off tool, the torch works with rapidity and efficiency, being one of the most rapid and practical devices known for cutting off steel sheet piling, beams and other heavy structural work.

HENDEY MACHINE CO., Torrington, Conn. Catalogue of an improved line of Lincoln milling machines. The Lincoln type milling machine is the standard manufacturing miller for armories, pistol factories, and other establishments where interchangeable parts are milled on a large scale. The company has developed this useful type of machine so that it is now being used successfully on operations which heretofore have been considered suitable for a knee type milling machine only. The catalogue illustrates the No. 8 Lincoln miller equipped with special table and chip pan; the same machine with high legs; improved Lincoln miller No. 5 with single and double spindles; and Nos. 4 and 2½ machines. All sizes are equipped with gear box giving twelve feed changes.

WATERBURY-FARREL FOUNDRY & MACHINE CO., Waterbury, Conn. General catalogue descriptive of all the lines of machinery built by the company, being a general reference book which briefly reviews the most prominent types of machines constructed. The catalogue comprises, rivet, bolt, and nut machinery, butt and hinge machinery, cartridge machinery, drop presses and hammers, screw presses, machinery for tubes and rods, hydraulic machinery, knuckle-joint press, special lathes, single-acting open-back presses, single-acting pillar presses, double-acting presses, shears and slitters, finishing machinery for sheet metal, mufflers and furnaces, wire-drawing machinery, eyelet machinery, gang slitting machines, etc. This catalogue is compiled in an attractive and interesting manner, making it a valuable work of reference as well as a catalogue of machinery in the various lines represented.

MANUFACTURERS' NOTES.

VAN DORN ELECTRIC & MFG CO., Cleveland, Ohio, has made Mr. A. N. Frecker sales manager. Mr. Frecker was for several years in the electric drill and grinder business in New York.

CINCINNATI IRON & STEEL CO., Cincinnati, Ohio, states that, owing to the heavy demand for the "Nugent" clutch, its machinery department is working full force day and night.

GENERAL ELECTRIC CO., Schenectady, N. Y., was awarded a grand prize at the Alaska-Yukon-Pacific Exposition for its exhibit of electrical apparatus and a completely furnished model apartment.

ROBBINS & MYERS CO., manufacturer of circular and desk fans, dynamos, motors, etc., has changed the location of its Chicago office from 48 West Jackson Boulevard to 501-515 West Jackson Boulevard.

KEUFFEL & ESSER CO., Hoboken, N. J., maker of drawing, mathematical and surveying instruments, measuring tapes, etc., was awarded the grand prize for its exhibit at the Alaska-Yukon-Pacific Exposition at Seattle.

GENERAL ELECTRIC CO., Schenectady, N. Y., and J. A. Roebling Sons Co., Trenton, N. J,, were awarded the grand prize at the Alaska-Yukon-Pacific Exposition for their exhibit of insulated wire and cable.

ROCKFORD LATHE & DRILL CO., Rockford, Ill., succeeds the Rockford Machine & Shuttle Co. A. Floburg is president; W. B. Johnson, vice-president and superintendent, and Charles Holmquist, secretary and treasurer.

HILL CLUTCH CO., Cleveland, Ohio, manufacturer of power transmission machinery, announces the appointment of Mr. G. W. Hoffman as sales engineer in charge of its Chicago office, located at 610 Marquette Building.

VARIABLE SPEED CLUTCH CO., Milwaukee, Wis., has opened a New York office at 50 Church St., Hudson Terminal Building, with Mr. W. L. Tenney, manager. Mr. Tenney was formerly with the Standard Heater Co., New York.

WARNER & SWASEY CO., Cleveland, Ohio, recently opened an office in Detroit, located in the new Ford Building. Mr. Thomas Farmer, who has for several years represented the Warner & Swasey Co. in the Detroit territory, will be manager of the new office.

SPRINGFIELD MFG. CO., Bridgeport, Conn., maker of special grinding machines and emery wheels, has been purchased by H. F. Brandes, former superintendent of the Bullard Machine Tool Co., Bridgeport, Conn. Mr. George W. Jackman, former owner, has retired.

LAKESIDE FORGE & WRENCH CO., Springfield, Mass., has acquired the plant of the Springfield Drop Forge Co., Springfield, which again began operations with a full force of men September 27. Mr. Eugene Childs, formerly connected with the Trimont Mfg. Co., Roxbury, Mass., is general manager and president of the company.

WARNER & SWASEY CO., Cleveland, Ohio, is building a large addition to its new plant which was partly completed before the late depression in business. The addition is a single story steel and concrete structure and is equipped with electric traveling cranes and other modern features. It will be completed about December 1.

JOSEPH T. RYERSON & SON, Chicago, Ill., are reported to be contemplating entering the field of machine tool manufacture, and negotiations have been made for a suitable location in Cincinnati on which to erect a large plant. The concern now is known as a manufacturer and distributer of boiler shop machinery and other iron-working tools.

LYON METALLIC MFG. CO., Aurora, Ill., has established an eastern branch with office at 1365 Hudson Terminal Building, New York. The concern manufactures a complete line of steel factory equipment, including lockers, racks, tables, etc., and its rapidly-growing business has made an eastern branch necessary. Mr. B. L. Waters, secretary of the company, is in charge of the eastern branch.

BAY STATE MACHINE CO., Erie, Pa., is the name of a concern newly organized to manufacture marine engines. The new company has bought the charter of the old company of the same name. The officers are John E. Waitz, president; Joseph Crawford, treasurer and manager; L. E. Safford, vice-president and sales manager; and Charles Boring, superintendent.

GENERAL ELECTRIC CO., Schenectady, N. Y., states that there is a large demand for its tantalum lamps, which because of their excellent life service and efficiency make a considerable economy in incandescent lighting possible. The life of a tantalum lamp will average about 600 hours. It can be used on an alternating current of 50 cycles or less.

LITHOPRINT CO., 41-43 Warren St., New York, is prepared to make black prints on white ground, absolutely true to scale, on any kind of paper including any drawing paper, bristol board or tracing cloth. The prints undergo neither water nor acid bath so are unchanged in scale. They are made as quickly as blue-prints, and are said to be superior to any blue-print in quality and finish.

SOCIÉTÉ FRANCAISE DES ROULEMENTS A BILLES, manufacturer of the RBF ball bearings, announces that Lavalette & Co. are no longer its representatives in the United States. The International Engineering Co., 1779 Broadway, is now the sole and exclusive agent for the sale of RBF ball bearings in America, and all inquiries should be addressed to it in the future.

S. A. WOODS MACHINE CO., Boston, Mass., manufacturer of wood planers, has taken Mr. W. S. Howe, formerly advertising manager in charge of the small tool sales department of the Canadian-Fairbanks Co., Ltd., Montreal, Canada, into its employ. The S. A. Woods Machine Co. has reduced its line of wood-working machinery to planers and molders, on which it now specializes.

B. F. STURTEVANT CO., Hyde Park, Mass., has established a savings bank life insurance agency at its works in charge of an instructor furnished by the savings insurance committee of the Boston Chamber of Commerce. This agency is established under the Massachusetts law which became operative November 1, 1907, permitting any savings bank to operate a department for issuing life insurance policies and old-age annuities.

DEPARTMENT OF COMMERCE AND LABOR, Bureau of the Census, Washington, D. C., has fixed on November 3 as the date for examining applicants for appointments as special agents for the collection of the 13th census of manufactures, mines and quarries. The circular lists the cities in the various States in which the examinations will be held and gives the requirements of the applicants and the rate of compensation for the work.

S. OBERMAYER CO., Cincinnati, Chicago, and Pittsburg, has placed a new foundry product on the market called "Bulldog" core wash. It is so called because of its adhesive qualities. Foundries using it have no troubles from the core wash burning or peeling off. The largest castings can be made with cores washed with the new preparation with no troubles from the iron sticking to the sand, and come out of the mold with clean, smooth surfaces.

SHEFFIELD GAS POWER CO., Kansas City, Mo., has acquired the entire assets, factory and good will of the Weber Gas Engine Co., at a bankruptcy sale. The factory has been in continuous operation throughout the receivership term and is being continued in full operation by the present owners. The management of the business is in entirely new hands; George M. Hawes is president; Freeman Field, vice-president and treasurer; and W. H. Spiller, assistant manager.

WARREN WEBSTER & CO., Camden, N. J., state that the patent decision in the case of Warren Webster & Co. *vs.* C. A. Dunham Co., mentioned in the October number, does not refer to about one hundred existing patents under which Warren Webster & Co. operate. The patent in this case expired over a year ago, and the suit merely involved a case of liability for damages on the part of the defendant. There are now pending in the Federal courts suits against users of the Dunham apparatus for infringement on patents which have not expired.

INTERNATIONAL ACHESON GRAPHITE CO., Niagara Falls, N. Y., is adding a substantial and commodious addition to its Niagara Falls, Ontario, works. The structure is to be 50 x 105 feet and the contract has been awarded to W. S. Homan, Niagara Falls, Ontario. The facilities afforded by this addition will make the Canadian works of the company quite complete and enable them to care for a rapidly growing Canadian trade. The building will contain a new grinding plant in which the lubricating, electrotyping and other grades of graphite will be prepared for the market.

MUSEUM OF SAFETY AND SANITATION, 29 West 39th St., New York, announces that a prize of 2,500 kronen ($612) was offered by Dr. Louis L. Seaman while at the XVI International Medical Congress, in Budapest, in September, for the best paper on the subject: "What should be the Status of the Medical Department of an Army in order that its Sanitation and Hygienic Conditions may be maintained at the Highest Efficiency so that in the Emergency of Battle its Units may best respond to the Call of its Commanders?" The award of the prize will be made by the executive committee of the XVII International Medical Congress.

DODGE MFG. CO., Mishawaka, Ind., lays claim to having the largest plant in the world for the manufacture of machinery for the mechanical transmission of power. Its buildings cover nearly 40 acres in a 60-acre plot on the Lake Shore & Michigan Southern Railway. In it there are annually worked up 2,000 tons of pig iron, 7,000,000 feet of lumber, 900 tons of steel and structural iron, 6,200 tons of steel shafting and 9,000 tons of coal. The resulting production is 250,000 "Independence" wood-split pulleys, 100,000 Dodge standard iron pulleys, 90,000 solid iron pulleys, 95,000 hangers, 150,000 bearings of all types, 4,000 friction clutches and over 2,000,000 pounds of bearing metal.

ROBERTSON DRILL & TOOL CO., Buffalo, N. Y., has moved from 1848 Niagara St., to its factory, corner of Grant and Letchworth Sts. The new building is of brick, two stories high with basement of concrete construction, the length being 150 feet and the width 50 feet. The basement is used for storage and a heating plant. The ground floor is the machine shop for the manufacture of its drill presses and power hack saws. The machinery is driven by a 30-horse-power electric motor, and the shop is equipped throughout with new tools. The office is at the east end of the factory, and the top floor is used for pattern making, etc. The foundry is adjacent to the new building to the north about 50 feet, and is equipped with modern foundry appliances including an electric crane. The anticipated output of the new plant is about twenty-five drills per day.

DAVIS-BOURNONVILLE CO., 97 West St., New York, has lately performed some interesting repairs with the oxy-acetylene apparatus. Among the repairs made are the following: A cracked kettle weighing two tons, thickness varying from 5 inches at the bottom to 3 inches at the rim was successfully welded. The crack was 18 or 19 inches long. A 15 ton gear wheel made in two sections was cracked through the rim which was about 22 inches wide. The rim was welded and one tooth 22 inches wide and 6 inches high was built up, machined to shape and made as serviceable as the original. The apparatus was used very successfully by a railroad company for cutting up old steam boilers. It is generally known that the cost of scrapping steam boilers is very heavy in comparison to the value of the scrap material. The apparatus did the work rapidly and at a comparatively low cost. Several other repairs were lately made,

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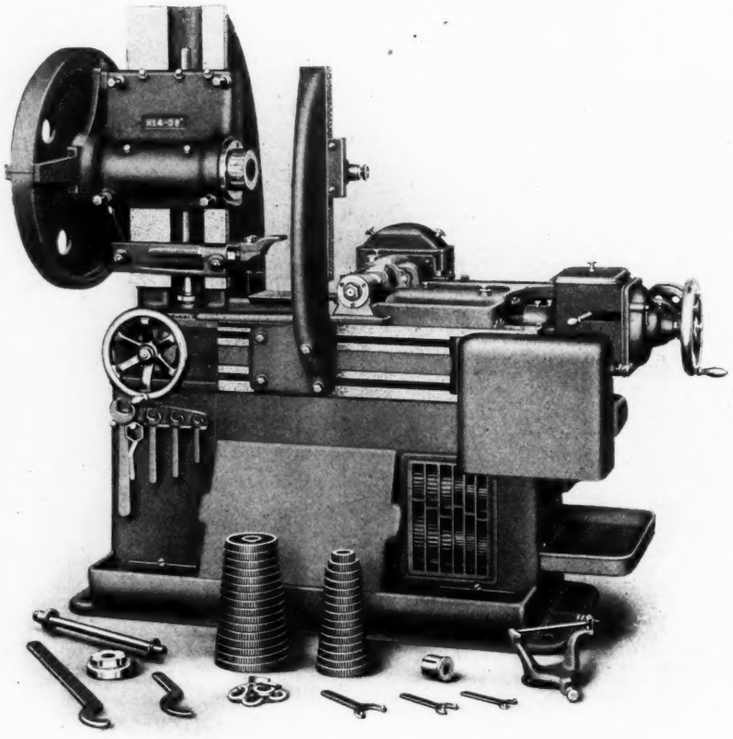
A RAPID PRODUCTION

is assured when you employ B & S Gear



The Automatic Gear Cutting Machine

shown in the cut above, is a representative example of this entire line and embodies many features in its construction that make it accurate and trustworthy in the cutting of all gears within its capacity.

Accuracy is insured by the unusually large correctly cut index wheel and also by the exceptionally rigid construction of every part.

The handiness of all controlling levers and handwheels together with the rapid operation of the indexing mechanism, assures a maximum production.

The variety of sizes in which these machines are made, fulfills every requirement of modern gear cutting practice.

SEND FOR SPECIAL CIRCULARS

B·S

BROWN & SHARPE MFG. CO.,

B·S

OF ACCURATE GEARS

Cutting Machines using B & S Cutters.

Cutters Made From Original Curves

were first introduced by J. R. Brown & Sharpe over 40 years ago. The system originated at that time has been continued and developed until **B & S Original Curves** have become **recognized** as **standards** in modern gearing practice.

The forms are carefully laid out and maintained, the cutters being as nearly exact copies as expert mechanical skill, aided by special machines, can make them.

The sides of the cutter teeth are exact duplicates, and their curves are carefully tested before the cutter is placed in stock. The teeth run true with the hole and are proportioned to give ample clearance for chips. Hardening and tempering are given especial attention; hence the great durability and remarkable uniformity of each successive lot of cutters.

All ordinary pitches are carried in stock and special cutters can be quickly made to order.

CORRESPONDENCE SOLICITED

PROVIDENCE, R. I., U. S. A.

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including welding steam dryer pipes, fly wheel spokes, broken hydraulic press platen, smoke-box heaters, cast steel water pipe tee 20 inches in diameter, etc. The cast steel tee was welded in the trench with about 4 inches of water flowing through it. It would have cost about $200 to repair the tee, beside shutting off the flow of water for a considerable time. The crack was about 9 inches long.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

ACTIVE PARTNER WANTED.—Owner of plant located in large city in the Middle West, manufacturing hoisting machinery, brick-making machinery, pumps and other special lines, desires to withdraw from active business. Will sell all or part of his holdings to right man on very liberal terms. Address Box 224, care MACHINERY, 49 Lafayette St., New York.

AGENTS IN EVERY SHOP WANTED to sell my sliding Calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

AN AMERICAN KNOWING EUROPEAN CONDITIONS thoroughly desires to represent some concern manufacturing an article of merit and upon which a good, steady and improving business could be founded. Would be willing to establish demonstrating room when necessary. Address Box 236, care MACHINERY, 49 Lafayette St., New York.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DRAFTSMAN.—Wanted young man thoroughly posted in designing and drawing presses, dies and sheet metal tools. SWAINE CO., St. Louis, Mo.

DRAWINGS, TRACINGS, ETC., MADE.—Prices reasonable. Box 1302, Orange, Mass.

FOREMAN DIE MAKER experienced on sheet metal dies of all descriptions. SWAINE CO., St. Louis, Mo.

FORMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in MACHINERY'S Reference Series, and for practical use in mechanical work is undoubtedly the most widely technical useful book published in years. Send for new coupon offers good until November 30, 1909. Address MACHINERY, 49-55 Lafayette St., New York.

HELP WANTED.—Energetic machine tool foreman producing gas engine parts. State salary, age, experience, etc. Write fully, time is important. WITTE IRON WORKS CO, Kansas City, Mo.

LATHE, PLANER AND BORING MILL HANDS WANTED for night and day shift. No labor troubles. Increasing forge. Applicants must state wages desired, past experience and if employed at present, to receive further consideration. Apply to INGERSOLL-RAND CO., Painted Post, New York.

MACHINIST AND ENGINEERS blue-print chart of U. S. Standard pipes and tapping, sizes from ⅛-inch to 10-inch pipe. Liberal discount to shop agents. Address CHARLES KUDERER, Woodlawn, Pa.

NEW YORK, PENNSYLVANIA AND NEW ENGLAND STATES.—First-class Gisholt turret lathe operators; men who can design and make tools, also run the lathes. Address Box 241, care MACHINERY, 49 Lafayette St., New York.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an investigation and report if a patent can be had and the exact cost. Send for full information. Trade-marks registered.

RATE SETTERS WANTED.—Must have had experience with time study method, using stop watches. Opportunities for advancement in Massachusetts plant building Engines, Marine Specialties, etc. State age, experience and salary expected. R. S. 25, Box 167, Boston, Mass.

USE OF FORMULAS and of Tables of Sines and Tangents, without a knowledge of Algebra or Trigonometry, is made easy to you by SHOP ARITHMETIC FOR THE MACHINIST, which is No. 18 in MACHINERY'S Reference Series described in sixteen-page pamphlet, sent on request. MACHINERY, 49-55 Lafayette St., New York City.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—Applications from Erectors, Layout Men, Production Men, Brass Finishers, Machine and Hand Molders, and Operators for Lathe, Planer, Drill, Turret Machines, Boring Mill, etc. Heavy and light work. Address DEPT. 53, BLAKE & KNOWLES STEAM PUMP WORKS, E. Cambridge, Mass.

WANTED.—One 50 to 75 H.-P. Corliss engine, one 50 to 60 K. W. 220-volt generator, one 80 to 100 H.-P. boiler. THE STERNBERG MFG. CO., Milwaukee, Wis.

WANTED.—A mechanical engineer or draftsman for general work in small growing concern. Should be familiar with gasoline engine design and willing to begin at moderate salary. Adress SUPERIOR IRON WORKS CO., Superior, Wis.

WANTED—PATTERN SHOP FOREMAN.—By one of the large up-to-date automobile factories in the Middle West. A man who is thoroughly versed in both wood and metal, also gated, plate, rockover, striping plate and other moulding machine patterns. Must be a man who is temperate, of good principles, and has had a large experience. An excellent position for the right man. State age, experience, present employer, salary wanted, and full details. Communications strictly confidential. Address Box 235, care MACHINERY, 49 Lafayette St., New York.

WANTED—MANUFACTURING SUPERINTENDENT.—For 2-cycle marine engine department. Must possess energy and be capable of producing a maximum and accurate output. None but thoroughly capable and experienced need apply. Give full details first letter. Address Box. 237, care MACHINERY, 49 Lafayette St., New York.

WANTED.—Draftsman familiar with design and construction of steam hammers. Write, giving references and stating salary expected. Address Box 238, care MACHINERY, 49 Lafayette St., New York.

WANTED.—At once, two or three good gas engine floor men. Apply by mail, stating experience and with references, to AJAX IRON WORKS, Corry, Pa.

WANTED by chief engineer, position as superintendent of power or pumping station, chief engineer of up-to-date concern, or in sales department of machinery or engine manufacturing company. Only position requiring a first-class, up-to-date man will be considered. Can furnish best of references as to ability and knowledge of this business. Anyone looking for a high-class man, kindly address Box 239, care MACHINERY, 49 Lafayette St., New York.

WANTED.—A first-class machinist for setting up and assembling machine tools. Opportunity for advancement to man with experience on similar work and capable of handling men. Give age, experience and wages expected. Address Box 240, care MACHINERY, 49 Lafayette St., New York.

WANTED.—One first-class tool maker. H. MUELLER MFG. CO., Decatur, Ill.

WILL SELL my jobbing pattern shop, or an interest to a live patternmaker proving his worth. J. L. GARD, Denver, Colo.